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METHODS OF SYNCHRONIZING ALTERNATORS

Description of the Lamp, Voltmeter, Synchroscope and Auto-Synchronizer Methods of Throwing Alternators in Parallel

BY C. PAGANO.

There are two methods of using alternators on the same circuit: in series and in parallel. The series system is not used because the machines required to work together should have their shafts rigidly connected so that they constitute a unit. The parallel system is generally used, but before the alternators can be connected in this way they must

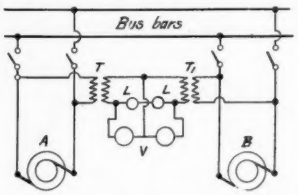


Fig. 1

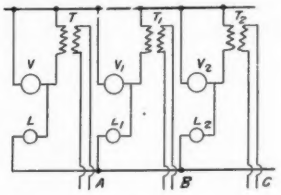


Fig. 2

have almost the same potential, they must have the same frequency and they must be in synchronism, the latter term meaning that the phases of their electromotive forces must have their maximum and minimum at the same instant. When these three conditions are fulfilled, the machines can be thrown in parallel without danger.

If the machines were a little out of synchronism, a transversal current, as it is called, would be generated from one machine to the other, the slower machine being accelerated and run as a motor and therefore brought to synchronism again. We have said "a little out of synchronism" because, if the difference in phase is an appreciable amount when connected in a circuit where already other machines were working at full load, these machines would be thrown out of synchronism, causing great oscillations and disordering the whole running.

The conditions necessary for the proper running of alternators in parallel are fulfilled by the following precautions:

a. Using engines at high speed with very sensitive governors and heavy fly-wheel capacity in order to meet with promptness the variation of the load; ready adjustment and uniform angular velocity.

b. Employing alternators with little self-induction and internal ohmic resistance, and with strong magnetic fields which will help the effects of the transversal current.

c. Having all the alternators, where possible, excited by the same current, thus reducing the regulation of all to a simple unit.

To know when the machines are in phase, three systems are used: lamps, voltmeters and special apparatus called synchroscopes. The operation of connecting in parallel is done by hand or automatically as in the case of the auto-transformer. We will give a rapid look at the lamp and voltmeter system and then spend a little more time on the special apparatus and their theory.

With low voltages it is sufficient to connect the machines to be coupled with two wires, each containing a lamp. When there is synchronism or difference of phase, the two currents act on the lamps as if they were diaphragms, vibrating when there is a little difference in the phase, the rapidity of the vibrations or undulations depending upon the value of this difference. In proportion as the synchronism is being approached, these undulations will be less rapid until they become so slow that the lamps will remain dark or steadily bright, according to the connections, indicating

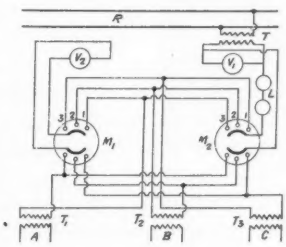


Fig. 3

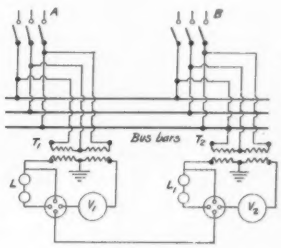


Fig. 4

the moment favorable to throw in the main switch. With high tension current, transformers are used and the lamps connected in the same manner as shown in Figs. 1, 2 and 3. The connections shown in Fig. 2 can be used for any num-

ber of machines, and the lamps are connected, as shown in Fig. 1, in such a way as to show synchronism when they are brightest. Fig. 3 shows an arrangement used by Brown & Boveri, in which the tension and synchronizing point are shown by the two voltmeters and the two lamps. A, B and C are the mains from the three alternators which are to be connected in parallel on the circuit R and T_1 T_2 T_3 are three step-down transformers whose primaries are in connection with the alternators to be connected in parallel, the secondaries being connected to two special commutators, M_1 and M_2. T is a step-down transformer for circuit R; M_1 is a commutator for reading the tension of the alternators

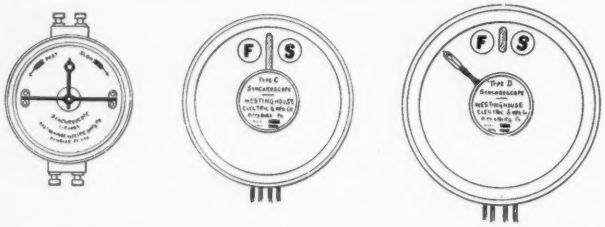


Fig. 5.—Type A Type C Type D

by means of the voltmeter V_2, so that it can be compared with the voltage V_1 of the step-down transformer; M_2 is the other commutator used for synchronizing the alternators by means of the two lamps L.

When a machine is to be connected to the circuit R, its tension is brought to the same value as the others, so that V_2 and V_1 read alike, and the lamps L are put in circuit by the commutator M_2. When synchronism is reached, shown by the maximum intensity of light in the two lamps, the alternator is thrown on the circuit R. Thompson-Houston, in order to avoid the dangers of strong transversal currents, use between the busses and the alternator, an inductive resistance which is gradually cut out. Ganz & Co. use a more rational but more complicated system. The alternator to be connected in parallel is loaded with great resistances on a large board of lamps until the number of amperes and volts to be given by the machine is equal to that of the others already in service. At this point the machine is synchronized by means of the arrangement shown in Fig. 1, and is thrown in parallel on the bus-bars with the load of resistance or lamps, which are gradually cut out. In this way every danger of transverse currents is perfectly avoided, but the system is complicated and quite encumbering.

The lamp system of synchronizing, although very generally used in the past, does not indicate how much the machines which are being synchronized are out of phase, and besides, the system is only sensible to angular differences of 40 or 50 degrees. With voltmeters, the synchronism is pointed out with more exactness and the scheme proposed by Mr. J. E. Woodbridge for a three-phase system is very accurate and reliable, and is worthy of mention. As shown in Fig. 4, the two transformer secondaries are connected to two different phases of the system in such a manner as to have their electromotive forces differing in phase by 60 degrees. Thus their resultant, when both are in phase, will be equal to the normal electromotive force, which will bring the pointer somewhere near the middle of the scale. The various differences in phase are therefore indicated with more accuracy and easily detected by the deflections of the pointer.

The necessity of rapid and safe methods of synchronizing has led to the construction of special instruments called synchroscopes. The first synchroscope was of the accoustic type, but was never used, being only a step toward what to-day is a useful and practical instrument. It consisted of two electromagnets, the enclosed diagrams of which were actuated by the current from the machine to be synchronized. When the generators were out of phase the apparatus would give out a loud sound, gradually growing feebler as synchronism was approached. The instrument was accurate, but its action could not have been detected in large and noisy power houses or on circuits of high frequency.

The modern, up-to-date synchroscopes, as constructed by the Westinghouse Company, are of three types, known as A, C and D. The A type is used for switchboards, and the C and D types are used for signal at considerable distance from the generator. Type A, as shown in Fig. 5 and diagrammatically in Fig. 6, has two coils A and B, at right angles to each other enclosing a small stationary coil C; inside of which an iron core is pivoted, constituting the movable part to which a pointer is attached. The coils A and B are connected in parallel to the main line, the first through a non-inductive resistance and the second through an inductive one, both being placed in series with them. By means of these two resistances things are so adjusted that the current passing through A is in phase with the voltage of the circuit, while the current passing through B is 90 degrees out of phase with that of coil A. As the current in

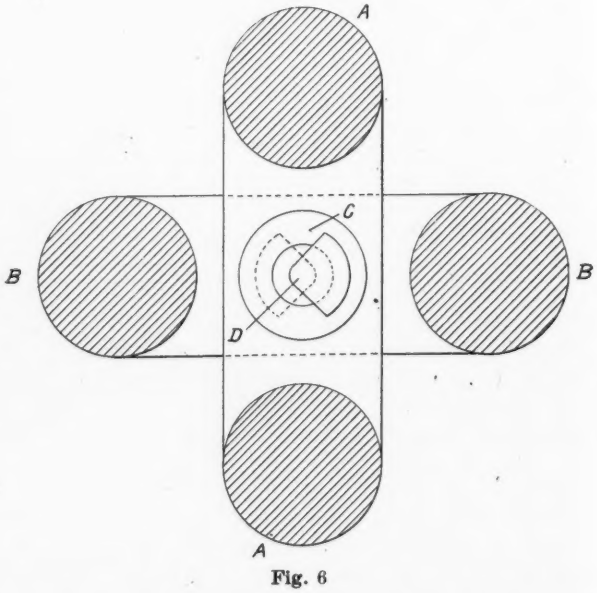


Fig. 6

coil A will be a maximum when that in coil B is zero and vice versa, the field produced by both will rotate with a speed depending on the frequency of the circuit on which they are connected. The small coil C is connected to the machine to be synchronized. In direction DB, the field will be zero when voltage in coil B is zero, and in direction DA when voltage on A is a maximum. Thus a zero field will be

found at any time between these two coils, at the maximum and zero voltage of A. The iron core inside of C will rotate for the attractions and repulsions of the two fields of A and B, and therefore it will take a position in which its zero field will coincide with the zero field of the rotating field.

Suppose the current in coil C is in phase with that in coil A, then the iron core will take a position in direction of DA, and if the current in C is at 90 degrees to that of A, it will rotate to the position DB. Hence for any difference of phase the core and consequently the pointer will take up a corresponding position, and if the difference will vary continually as in the case of two machines to be synchronized, the pointer will rotate until, when synchronism is reached, it will stop right on the painted pointer in the middle of the dial. If the machine, which is being brought into synchronism, is running slow, the pointer moves to the right, while if fast, it moves to the left.

The construction of types C and D, shown in Fig. 5, is similar in principal to type A, but has different mechanical features. It would be perfectly correct to say that the whole mechanism represents a small induction motor whose stator

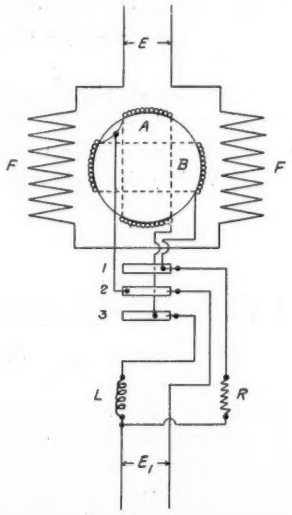


Fig. 7

is connected to the bus-bars, and whose rotor, formed by two windings, one at right angles to the other, receives its potential from the incoming machine. The two windings of the rotor are connected in series, the two extreme terminals of which are soldered to two rings lying on the shaft on which the rotor is mounted, and the common juncture is soldered to a third ring. One winding is connected to the secondary machine through a non-inductive resistance, while the other is connected through an inductive one, so that the difference of the currents between them is 90 degrees behind the electromotive force E, Fig. 6, on account of the high inductance of the coils FF, and consequently the magnetism will be 90 degrees behind the electromotive force.

When the current in winding A of the rotor, Fig. 6, is in phase with the field magnetism, A will swing to assume a position where its plane will be at right angles to that of the field, the current in A being 90 degrees behind the electromotive force E_1 on account of the action of the inductance L. The current in B, connected through a non-inductive resistance is in phase with E_1, but 90 degrees out of phase with the field magnetism, so at synchronism no torque is exerted on it, the frequency of E and E_1 being equal. But supposing E and E_1 differ in phase by 90 degrees, then the current in A is at right angles to the field while that of B is in phase with it and hence B will assume the vertical position swinging around through 90 degrees. For phase differences of less than 90 degrees, the pointer, which is attached to the

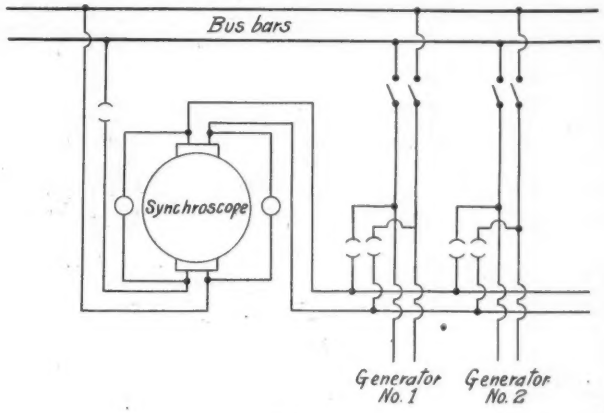


Fig 8

shaft, will assume intermediate positions, and if the frequency between the two electromotive forces are different, the pointer will rotate forward or backward, showing if the incoming machine is slowing down or running too fast. As actually constructed, especially in type D, Fig. 5, which is the largest type made, the diameter being nearly 36 inches, the pointer has at its extremity a small lamp, and the dial has the two initials F and S, and the right point of synchronism indicated. Such large types are elegantly mounted on pedestals, and put in a suitable place on the dynamo-gallery so that it can be distinctly seen by the operator at the switchboard. As shown in Fig. 8, these types of synchroscopes are connected to the circuits in a very simple

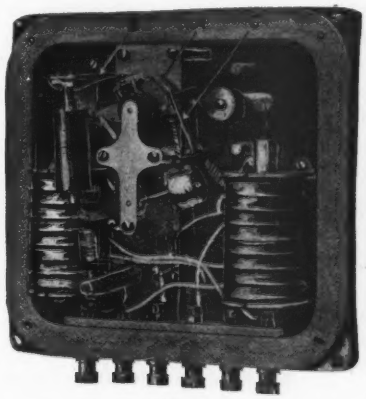


Fig. 9

manner, voltage transformers being used from 200 volts up.

While these types of synchroscopes point out the exact moment of synchronism, they thrust on human beings for closing the switch at the proper time, and, indeed, in this wonderful age of more wonderful mechanical appliances, they are not the ideal instruments that the auto-transformer

is, which take away the necessity of human help and depend upon mathematically exact movements settled beforehand. It is a welcome and long-desired instrument, small in size, elegant, and of very substantial construction. It is constructed as shown in Fig 9, and consists of two solenoids, A and B, acting on cores hung on opposite sides of a rocker arm, which carries at its centre a segment of fibre, on one

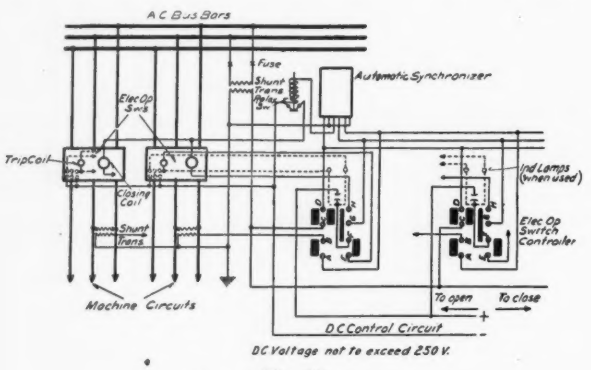


Fig. 10

side of which a metallic contact of proper length is mounted. The rocker-arm has on one side a brush consisting of a thin steel blade, while another similar blade is screwed on the base plate on the opposite side and a little downward. Counter-weights, dash-pot and springs are used in adjusting the instrument to suit the circuit on which it is required to work. The two solenoids are connected in such a way that the right hand of the rocker-arm is at the lowest position of its stroke when the electromotive forces to be synchronized are in phase, and at the top of it when the phases are in opposition. Thus the rocker-arm will be compelled to swing up and down in following the variation in the electromotive forces. When synchronism is approaching, the rocker-arm will swing down, and hence operates the fibre segment and brush in such a manner as to connect it with the stationary brush through the metallic contact mounted on the insulated segment. This contact will close the circuit of a relay and act on the coil of the electrically operated switch. Connection before or after synchronism is avoided by the action of the dash-pot, counterbalanced by the adjustable weight. Mechanical adjustments fix things in such a manner as to close the contacts of the operated switches an instant before perfect synchronism, so that when the contacts are closed, a fraction of a second will elapse and synchronism has arrived at its proper point. There will then be no danger of strong or dangerous transversal currents. This means that the instruments must be adjusted for the time element, which is one-quarter of a second for the air-brake type and from one-half to one second for oil switches as used on high tension.

This automatic device is absolutely reliable, and does away with pointers, dials and lamps, and makes a very neat appearance on the switchboard. Fig 10 shows the wiring diagram used for connecting the auto-synchronizer to the switchboard.

COMBINATION OF INDICATOR CARDS

Methods of Laying Down Compound Engine Cards to the Same Scale and Volume

While the results obtained from the combination of indicator cards taken from a compound or multiple-cylinder engine may not always result profitably to the engineer, because very often the losses in the engine indicated by the combined diagrams may be due to the design of the engine over which the engineer has no control, yet there are often cases in which there are steam losses between the cylinders which can only be detected by laying down a combined diagram of the cards taken from the different cylinders.

To be able to properly combine the indicator cards taken from a multiple cylinder engine, all the dimensions and clearance of the engine cylinder should be known, together with the scale of spring with which the different diagrams are drawn. Having this data, it is then only necessary to lay down the cards on a large piece of paper drawing all the cards to the same scale and pressure, so that if there were no heat losses in the cylinders and receivers, the result would be one complete indicator card from admission in the high-pressure cylinder to the back-pressure line in the low-pressure cylinder, and from the release in the high to compression in the low.

Any divergence between the path which the steam should make and that which it does make is clearly shown when the cards are combined, so that if the design of the engine will permit it, this difference, which generally means loss, can often be reduced or adjusted.

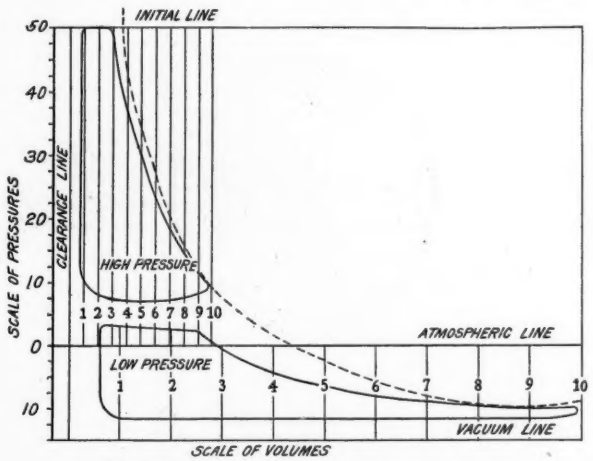
The losses which take place in a compound engine are caused by condensation in the ports and pipes, friction in the passages and pipes, and free expansion between the cylinders. The most economical engine reduces these losses to a minimum. If it were possible to take a combined indicator card from the cylinders with one indicator, it would not be necessary to combine the cards, as will be shown here; but since two cards are taken from the different cylinders, which look almost often exactly alike, they do not on their face represent the true relative conditions which are taking place in the cylinder.

To combine any two diagrams from a compound engine, the clearance in each cylinder must be known, and the length of the combined diagram and the scale of pressures with which the cards are drawn must be decided upon. It will generally be found convenient to use the low-pressure scale for a scale of pressures, and any convenient length for the length of the low-pressure card may be selected. Then draw the atmospheric line and vacuum line according to the chosen scale, and erect a perpendicular which will represent the zero clearance line. All measurements of length must be made from the clearance line, and all measurements of pressure must be made from the atmospheric line.

The total volume of a steam cylinder is the volume swept through by the piston plus the clearance volume. The total volume divided into the clearance volume gives the clearance in

per cent. The clearance of any engine can generally be obtained from the engine builder who keeps the dimensions of the engine manufactured by him on file, and as each engine is numbered, it is no difficult task for the builder to keep these records. Should, however, it be necessary to find the clearance experimentally, the engine must be put exactly on centre, and if the engine does not leak, the volume of water poured in to fill the clearance spaces will give the clearance of the cylinder. The latter method must be cautiously performed, because should there be any leakage of the valves or around the piston rings the measurements will be of no value.

The clearance of both the high and low-pressure cylinders being known, they should be laid out from the admission line on the individual cards which are to be combined, and the cards should be divided into ten equal parts. The low-pressure card may then be laid down on the combined diagram according to same scale with which it was drawn, but according to the new length selected. The pressures can be transferred directly with a pair of dividers from the lines on the original to the lines on the combination card, connecting the points laid off on the different vertical lines. The result will be an elongated diagram from the low-pressure cylinder, just as though it had been taken with the same spring, but with a larger drum on the indicator.



Method of Combining Indicators Cards

The clearance line and the length of the high-pressure diagram must next be located on the combined card. The length of the high-pressure diagram compared to that of the low-pressure diagram is determined by the ratio of the total volume of the cylinders. If, for instance, the low-pressure cylinder contained exactly three times the volume of the high-pressure cylinder, the length of the low-pressure card would be three times greater than the length of the high-pressure card. The clearance of the high-pressure card must also be laid off from the clearance line in the same reduction.

Having then divided the length of the original card into ten parts, and the length it is to occupy on the combined diagram also into ten parts, the heights which must be laid off on the different lines depends upon the ratio of the scale of the spring with which the original card was drawn and the scale with which the low-pressure card was laid down on the combined diagram. If the original high-pressure diagram was taken with a 40-pound spring and the combination diagram was drawn to a scale of 10 pounds, the new high-pressure diagram will consequently be four times as high as the original, although, of course, shorter. All of the points of both original diagrams having been transferred to the combined diagram, a curve may be drawn through these points with the result as shown in the accompanying sketch.

To obtain the losses occurring in the transfer of the steam from one cylinder to the other, draw the hyperbolic curve through the exhaust point of the high-pressure curve. This curve is drawn from point, where the zero clearance and vacuum line meet. The area between this hyperbolic curve and the curves of the diagram, and the opening between the two diagrams represents the losses in the engine. If it were possible to completely abolish the losses between the cylinders, and should the steam expand in the same manner as a perfect gas, the combined diagram would be a perfect one, and there would be no opening between the high and low-pressure cards.

Even though the result of combining the indicator cards from a compound engine may not be of any practical benefit, there is no better way of thoroughly understanding the meaning of compound engine cards than that which is had in laying them down as described here.

Horse Power of Gasoline Engines.

At the recent meeting of the mechanical branch of the Association of Licensed Automobile Manufacturers, a horse power formula was adopted which is to be used in the rating of automobile engines. The formula adopted is

$$\text{Number of horse power} = \frac{D^2 \times N}{2.5}$$

in which D represents the cylindrical diameter and N the number of cylinders. By means of this formula the following table, taken from the "Horseless Age," has been calculated:

Bore of Cylinder, Inches.	Number of Cylinders. Horse-power. 1.	2.	3.	4.	6.
3	3.6	7.2	10.8	14.4	21.6
3.25	4.2	8.4	12.7	16.9	25.3
3.50	4.9	9.8	14.7	19.6	29.4
3.75	5.6	11.2	16.9	22.5	33.7
4	6.4	12.8	19.2	25.6	38.4
4.25	7.2	14.4	21.7	28.9	43.3
4.50	8.1	16.2	24.3	32.4	48.6
4.75	9.0	18.0	27.1	36.1	54.1
5	10.0	20.0	30.0	40.0	60.0
5.25	11.0	22.0	33.1	44.1	66.1
5.50	12.1	24.2	36.3	48.4	72.6
5.75	13.2	26.4	39.7	52.9	79.3
6	14.4	28.8	43.2	57.6	86.4

In 1906, it took 55,746,374 tons of coal, valued at $62,232,524, to make 36,401,217 tons of coke, valued at $91,608,034. Of the total output, 31,843,900 tons were made in bee-hive ovens and 4,588,127 were made in by-product ovens. The average price of the coke produced was $2.52. The large amount of coke produced was due to the large production of iron and steel. Many of the coke ovens in this country are operated by large corporations, which operate also coal mines and blast furnaces, the coke-making being only an incidental part of the business.

THE MEASUREMENT OF POWER

The Indicator, Brake and Electrical Methods of Finding the Amount of Power Given out by an Engine

CARL H. CLARK, S. B.

The question, "How much power?" is a very important one in the field of engineering at the present time. In almost every case where power is generated, it is necessary or desirable to know the amount; at least, approximately. While an extended explanation of the terms is not necessary for the readers of this magazine, the terms "force," "work" and "power" should be carefully distinguished. A "force" is something which can produce "work" by acting through a certain space. In other words, "work" is the product of a certain force acting through a certain space. Thus, a force of 2000 lbs. acting through a distance of 33 feet produces work to the amount of 66,000 foot pounds. This is independent of the time, and might be done in one minute or one hour, and still the same amount of work be done. "Power," on the other hand, represents the rate at which the work is done, a "horse-power" being the capacity for doing 33,000 foot pounds of work per minute. Thus, if the 66,000 foot pounds of work above mentioned were done in one minute, it would be at the rate of $\frac{66{,}000}{33{,}000} = 2$ horse-power.

There are three general methods of determining the amount of power generated, namely:

(1) By use of the indicator.
(2) By some form of brake.
(3) By the electrical method.

The choice of these methods depends upon the circumstances under which it is to be used.

(1) *Indicated Horse-Power, or I. H. P.* This method is used almost entirely in determining the power generated by a reciprocating engine, either steam or other form. Calculation by this method is dependent upon the use of the indicator. Without entering into the details of the indicator, an instrument which is familiar to the large majority of engineers, it may simply be noted that it is an instrument by which the pressure acting in an engine cylinder is recorded throughout all points of the revolution. From this record, or "indicator card," the average pressure acting upon the piston, or the "mean effective pressure," may be found. This is usually abbreviated M. E. P. The M. E. P. is thus the force which, acting on the piston, produces the work. If now, we call the M. E. P. simply "P" and the area of the piston in square inches "A," we have $P \times A$ as the force acting upon the piston. If now this force is multiplied by the length of the stroke in feet "L" we shall have $P \times A \times L$ as the work done per stroke. Since a horse-power means the performing of 33,000 foot pounds of work per minute, we shall have as many horse-power as the total work will contain 33,000. We shall then have $P \times A \times L \div 33{,}000$ as the horse-power per stroke. We have, then, only to multiply this last by the number of working strokes per minute to obtain the indicated horse-power.

In the case of the ordinary steam engine, which is double-acting, there are two working strokes for each revolution. If we call the number of revolutions per minute "N," we shall have $2 \times N$ as the number of working strokes per minute. We shall then have for the double-acting steam engine

$$\text{I. H. P.} = P \times A \times L \times 2 \times N \div 33{,}000$$

or, as it is customarily written for ease in remembering it,

$$\text{I. H. P.} = 2\ P\ L\ A\ N \div 33{,}000$$

which is the usual form. It must be remembered that the area of the piston is in square inches, the length of stroke in feet, and the revolutions per minute. It may seem strange that some factors should be measured in feet and others in inches in the same formula; it is, however, the custom to do so, and it makes little confusion after one is accustomed to it.

In the case of internal combustion engines the same general method may be used with slight modifications. In the single-acting, two-cycle type, where there is one impulse, or working stroke during each revolution, the I. H. P. $= P\ L\ A\ N \div 33{,}000$.

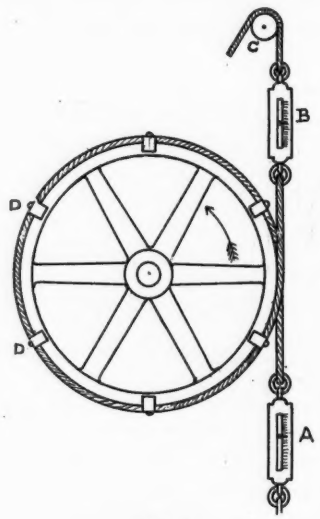


Fig. 1

For a four-cycle gas engine, giving an impulse on each alternate revolution, the number of working strokes per minute is ½ N, and the

$$\text{I. H. P.} = \tfrac{1}{2}\ P\ L\ A\ N \div 33{,}000, \text{ or } P\ L\ A\ N \div 66{,}000$$

The formulas for the I. H. P. are, of course, for one cylinder, and must be multiplied by the number of cylinders.

The indicated horse-power is thus a measure of the work done in the cylinder, rather than of the power delivered by the engine. It is plain that a certain amount of power is necessary to overcome the friction of the several parts of the engine itself, or, as it is termed, the "engine friction." It is possible that an engine may show a considerable horse-power by the indicator calculation, and yet be readily stopped by pressure of the hand on the fly-wheel, showing that, although the power is being developed in the cylinder, it is not available at the shaft, but is used up in the friction of the working parts.

In practice this discrepancy between the indicated and actual horse-powers is not as great as it might appear, as the two bear a fairly constant proportion in engines which are in good

condition. The proportion which the actual horse-power bears to the indicated horse-power is termed the "mechanical efficiency." It might be further defined as the percentage of the indicated horse-power which is available at the shaft. For small steam engines the mechanical efficiency may be from .75 to .85, while for large triple-expansion engines it may run from .85 to .90. For gas engines a fair average efficiency is perhaps .80 for small engines and .85 for large ones.

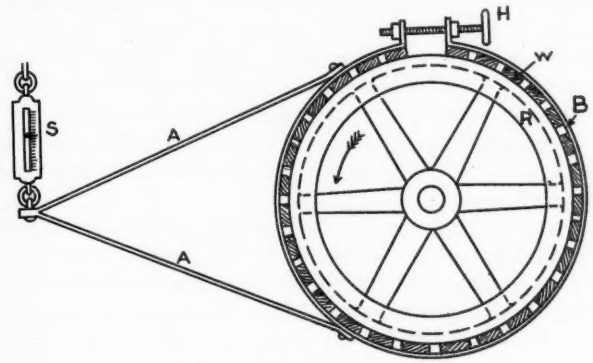


Fig. 2

Taking all the factors into consideration, the indicator method remains the most convenient, and in some cases the only possible method of determining the power of reciprocating engines.

The indicator card, besides giving the data for figuring the horse-power, also shows much regarding the setting of the valves and the general operation of the engine.

(2) *Brake Test.* Where it is possible to apply it, the brake test gives a very satisfactory and easily-applied means of determining the horse-power. This method gives directly the actual horse-power which is available for use at the shaft, without regard to the mechanical efficiency of the engine. The horse-power thus obtained is called the "brake horse-power," or B. H. P.

The power is absorbed by some form of friction brake, usually on the fly-wheel, by which it can be absorbed and measused at the same time.

The simplest form of brake is the rope brake, as shown in Fig. 1. It consists of a series of turns of rope around the fly-wheel, the ends of the rope being connected to a spring scale AB. Some means of varying the tension in the rope is provided, such as a pulley at C. The fly-wheel is supposed to turn in the direction of the arrow. The tension is adjusted until the engine runs steadily at the desired rate. The pull on both spring scales is then read off, that on A being found to be the larger. Since these two scales oppose each other, the difference between their readings will represent a net force, which we may call P. It is this force P which, acting at the rim of the fly-wheel, absorbs the power of the engine. It may then be considered that the power is generated by a force equal and opposite to P moving around the circumference of the wheel. If we call the diameter of the wheel, in feet, D, the circumference will be $3.1416 \times D$, and the work done during one revolution of the wheel will be $P \times 3.1416 \times D$. Again, if we call the number of revolutions per minute N, the work done in one minute will be $P \times 3.1416 \times D \times N$, and if we now divide this result by 33,000 we shall have $P \times 3.1416 \times D \times N \div 33{,}000$ as the horse-power developed.

Small chock pieces of wood may be fitted, as shown at D D, to prevent the rope from slipping over the edge of the fly-wheel; for very small powers, however, where there are only two or three turns of rope, these may not be necessary. The face of the wheel is lubricated and the number of turns of rope so adjusted that the power is absorbed without an undue amount of tension in the rope. It is plain that this form of brake cannot be used for a long test on account of the amount of heat generated and the lack of means for getting rid of it. For occasional testing where the power is not large, this form of brake will be found to be very convenient and satisfactory.

In cases where the power to be measured is greater, the "Prony" brake illustrated in Fig. 2 is used. It consists of a metal band B encircling the wheel. Inside of this band, and resting on the face of the wheel, is a series of wooden blocks W W. By means of the band wheel H, the tension in the band B may be varied, to make it clasp the wheel more or less tightly. To the band B a frame, or pair of arms A A, is fitted, to the end of which a spring scale S may be attached.

With the wheel turning in the direction of the arrow, the hand-wheel H is tightened gradually, until the wheel turns steadily at the proper rate. The pull on the spring scale is then read off. The figuring of the power with this style of brake is the same as in the previous one, the horse-power equals $P \times 3.1416 \times 2 \times R \times N \div 33{,}000$, where P is the pull on the scale S, in pounds, R is the distance from the centre of the wheel to the point where the scale is fastened, N is the number of revolutions of the wheel per minute.

This style of brake may be applied to the face of any fly-wheel, although, with the usual fly-wheel, it can only be used for a short test on account of the heat generated. When it is necessary to use the brake for any length of time, a special wheel may be used, having a deep trough-like rim, R. Water may then be fed into this rim, to be distributed over it by centrifugal force. The heat generated by the friction is then absorbed by evaporating the water, thus allowing the brake to be used almost continuously. The water is, of course, replenished from time to time as it evaporates.

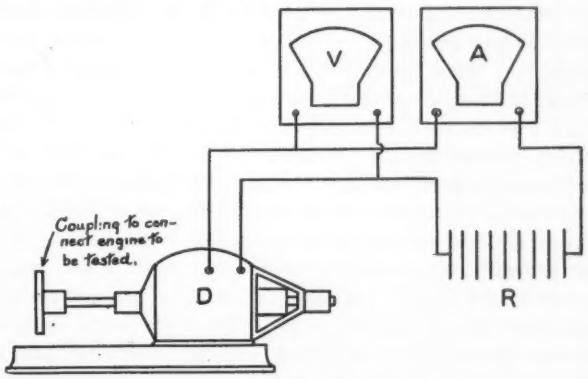


Fig. 3

In cases where a considerable amount of testing is to be done, a brake of this kind may be made, with wheel and bearings complete, entirely independent of the engine to be tested. It may be supplied with a coupling, so as to be readily attached to any engine as desired. Where the brake is of large size, the pull may be measured by resting the end on a platform scale. When this brake is of sufficient size, quite large powers may be measured.

(3) *Electrical Test.* The electrical method of determining the horse-power is comparatively simple, and can be applied to any condition. By this method the power generated is converted by a dynamo into electrical energy, which can be readily absorbed and measured. The principal source of uncertainty is the efficiency of the dynamo; that is, the proportion of the power required to drive it, which it is capable of giving out again as electrical power. The efficiency of the dynamo may readily be found for each power, so that the uncertainty is very small. In operation the engine is coupled to the dynamo. The power generated is measured by volt and ammeters, and then absorbed by some form of electrical resistance, either lamps or water resistance.

Fig. 3 shows the general connections for this test. The current generated by the dynamo D is measured for voltage by the volt meter V and for amperes by the ammeter A, and is absorbed by the resistance R, which is capable of being varied to suit the conditions. The average of each of these is then figured. From these averages the horse-power can be figured. The product of the amperes multiplied by the volts gives the number of "watts," which is the electrical measure of power. A horse-power is equal to 746 watts, so that if the number of watts developed is divided by 746, the result will be the horse-power developed by the dynamo. As the dynamo will not give out as much power as is put into it, the amount of power developed by the dynamo must be divided by the dynamo efficiency (expressed as a decimal) to obtain the power developed by the engine. We thus have

$$\text{B. H. P.} = \frac{\text{amperes} \times \text{volts.}}{746 \times \text{efficiency.}}$$

This method is good for general use, as the electrical connections may be made permanent, all that is necessary being to couple up any desired engine to the dynamo.

As will be seen, this method is capable of very general application, all that is necessary to know being the dynamo efficiency for each output. The number of revolutions of the engine does not enter into the final calculation for the power, but are recorded in order that the power for each rate of speed may be known.

In choosing from the various methods of finding the power, one must be guided by the conditions, the facilities at hand, and the degree of accuracy with which the power is to be determined. If only an approximate determination is needed, a short test with some simple apparatus will be sufficient; if, however, accurate results are required, the apparatus must be so fitted as to allow a test of considerable length and the taking of accurate readings.

A TALK WITH A CHIEF ENGINEER

Practical Pointers in Reference to Charging and Discharging Storage Batteries

By William Kavanagh.

Talk No. 5.

When Kingsley and I arrived at the chief's engine room at the appointed time to continue our talks, the chief began by saying that he had neglected to illustrate some very interesting facts in relation to freezing. "You know," he said, "that when ponds, rivers and lakes become frozen, it maintains the temperature of the surrounding country sufficiently high to preserve animal and vegetable life, because the very act of freezing means that the bodies of water which have become frozen had to part or give up a certain quantity of heat before forming the ice; hence the stored heat which large bodies of water contain tends to equalize the temperature and preserving life. It is a well-known law in physics that the freezing of a given weight of water means the extraction of a certain amount of heat, which amount of heat is exactly equivalent to the quantity of heat necessary to melt the ice into water, so that the heat is not lost or destroyed, but simply transferred. It is also generally known that when a liquid forms a gas, heat is absorbed, and when a gas forms a liquid, or a liquid forms a solid, heat is given off. Therefore, for a body to remain in the gaseous state it must retain heat, and the amount of heat retained by the gas is called 'latent heat.'

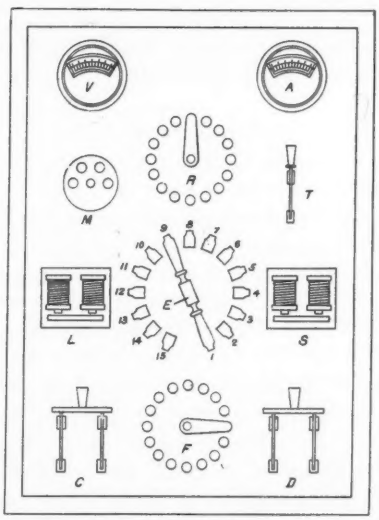
"Heat," continued the chief, "may be defined as a vibration of molecules; the greater the amplitude of vibration, the more intense the heat; in fact, heat may be considered the medium of exchange in the world of energy. Cold," continued the chief, "is defined as the absence of heat. There are various degrees of cold, as well as of heat, which is measured or calculated in different ways, but I will leave these discussions until some future time."

At this point the chief asked Kingsley when he expected to have the storage battery in operation, and Kingsley replied that they expected to have the battery ready in about three weeks. "Well," said the chief, "you must study up on the storage battery so as to understand how to charge and discharge the cells, how to keep the cells clean and how to keep the electrolyte at its proper strength. If you understand these four things, you will be able to handle the battery all right; in fact, a little practice with the battery will make you familiar with its operation if you have studied up on the subject. You know," the chief said, "that it is just as important to understand the storage battery and its method of operation as it is to understand the dynamo, especially when the storage battery comes directly under your supervision. Let me say right here that there are hundreds, yes thousands, of persons operating storage batteries and dynamos who do not know or do not care to know the principles of these two sources of electricity. Such men seem to be satisfied as long as those machines operate, but when anything occurs they are unable to locate the difficulty, and when experts must be sent for in order to remedy the defect it tends to lower the standard of the operating engineer and places him in a disadvantageous position.

"To begin about your storage battery, I understand, Kingsley, that you carry 250 volts on your dynamos," said the chief, "and in order to learn the number of cells necessary to carry this voltage we must divide the voltage of the dynamo by two. Therefore, the number of cells in series must equal 125. If, however, only this number of cells are installed, there is no possible way of raising the voltage, so that an extra number of cells must be added to enable the raising of the voltage and

to maintain it constant for any length of time. Therefore, a number of extra cells are used, and as the voltage of the battery drops, one or more cells are added to the series and by constantly adding cells, the electro-motive force of the battery can be maintained practically constant within narrow limits. The number of end cells placed in the battery room vary with different manufacturers; some erect more than a dozen, while others put in less; in any case, the more numerous the end cells, the greater will be the length of time that the battery can maintain its voltage constant. You can readily see that if it takes 125 cells to give out an electro-motive force of 250 volts, it would be impossible to raise the voltage to 252 volts, unless we added another cell to the series; hence, as the voltage drops, end cells must be added until finally all of the end cells are connected to the line. It will then be time to charge the battery.

"To charge the storage battery, connect the dynamo to the switchboard and pull out the discharge switch of the battery. The dynamos will now be carrying the battery load, and, of course, its voltage can be arranged to suit the usual conditions. The next step in the charging of the battery is to start the booster, and when the booster is up to speed, close the circuit-breaker and equalizing switch on the battery panel board and note how high the booster has elevated the voltage above the line voltage, and if upon inspection it is found that this voltage is a few volts higher than that of the line, we may connect the charging switch to the board and cut out resistance from the booster field by means of the booster rheostat. We may continue cutting out resistance until the battery ammeter indicates, say, one ampere for each cell. It is not absolutely necessary to charge at the rate of one ampere per cell, but it can readily be seen that charging at the rate of one-half ampere per cell will take double the length of time to charge the battery, and if we double the charging rate it will take one-half the time to charge.



Booster Panel for Charging Storage Batteries

"A medium rate of charge should be adopted," continued the chief, "and, when once applied, should be maintained as constantly as possible. By doing so, each cell receives the same quantity of current so that each cell will wear away evenly. If the cells are charged at a high rate of current the plates will rapidly weaken or waste away, and in a like manner, if the batteries are discharged at a high rate, the same thing occurs; hence, a medium rate of charge and discharge should be used.

"When the battery is in operation in your plant," explained the chief to Kingsley, "there will be attached to your regular switchboard an extra panel which will be called the 'booster panel,' as it is very likely the regular switchboard will not have the room to accommodate the necessary instruments for the charging and discharging of the cells.

"The battery, or booster panel, is usually attached to the main switchboard, or is put in some convenient place. It is fitted with instruments as shown in sketch. The voltmeter is shown at V, the switch M being used to connect the voltmeter with the battery, the booster or the dynamo, as desired, so that by changing the switch from one point to another the different voltages may be obtained. The ammeter is shown at A, and its readings show the amount of current going in or coming out of the battery at charge and discharge. S is the underload switch, and as long as the electro-motive force of the booster is not sufficiently high to force current through the battery, this switch will not stay closed. The overload switch is shown at L, and it will open at overload or upon a short-circuit. R is the booster starting rheostat and T is the equalizing switch for booster and dynamo. E is the end cell switch, and in this case it shows there are 15 end cells connected to it. The booster field rheostat is shown at F, and by cutting in or out resistance with this rheostat the booster voltage can be raised or lowered as required. D is the discharge switch and C is the charge switch. This sketch contains all of the operating instruments, and if, Kingsley, you study up the different instruments and connections, you will have no difficulty of operating storage batteries.

"The method of operation is as follows: After the dynamo is connected to the board, open switch D and start the booster by means of the starting resistance R. When the booster is up to speed, throw in the equalizing switch T. Next raise the booster voltage by cutting out resistance with rheostat F, and when this voltage is from 5 to 10 volts higher than the line voltage, connect C to the board and cut out resistance with F until the ammeter A shows one, or one and one-half, amperes per cell, and if the end-cell switch E is on the last cell, or any other cell, it can remain in that position and afterwards be moved around in either direction.

"It is usual practice, however, to have the end-cell switch shifted to or connected on the last cell before charging begins. Thus, in the figure, the end-cell switch E is connected to No. 1 cell, which cell is the last in the series to be discharged, and therefore it will be the first to which the end-cell switch will be connected on charging. When the battery is charged, the switch E will be connected to No. 15, and when the battery begins to discharge and its voltage lowers, switch E can be moved around to Nos. 14, 13, 12, 11, and so on, until finally it has reached No. 1, when charging must begin. To stop charging, open charging switch and bring the booster to rest by means of the resistance R."

As Kingsley and I had to return to our engine rooms, the chief said he would stop at this point and devote his next talk to the cleaning of storage battery cells and the maintenance of the gravity of the electrolyte, and he would also tell us when the cells were charged and discharged.

POWER HOUSE PRACTICE

Answers to Questions Asked By the Street Railway Engineering Association

In connection with the recent convention of the American Street and Interurban Railway Association, held at Atlantic City, N. J., a number of questions were asked the Engineering Association which were answered by its members, each question representing a topic which is of present importance. The answers show quite a difference of opinion, as might be expected, as they come from men who have had different engineering experiences in different parts of this country. A few of the questions pertaining to power house practice, asked, and the answers follow:

Q. 1.—Is the use of jet condensers on turbine installation advisable?

No. Better vacuum with surface and use condensed water in boilers.—Auburn & Syracuse Electric Railway Company, Auburn, N. Y.

Have found the use of jet condensers on turbines advisable from several standpoints. First: decreased cost over surface condensers. No tubes to become leaky and split. Ability to carry as high a vacuum as with a surface condenser and decreased maintenance. If injection water is not salt, this can be used for boiler feed, its temperature being as high as the hot well water of the surface condenser.—Lynchburg Traction & Light Company, Lynchburg, Va., A. J. Kohler, chief engineer.

The use of jet condensers on turbine installation is not advisable. Surface condensers work successfully and give best satisfaction.—Little Rock Railway & Electric Company, Little Rock, Ark.

The use of surface condensers in connection with the steam turbine is an ideal condition if the condenser can be kept tight. The absence of all oils in the water of condensation makes it an excellent boiler feed water. Surface condensers around the city of New York have not, as a rule, been a very great success. In only a very few places have they been able to use their water of condensation. The cost of labor and material necessary to keep the condenser tight more than offsets the saving that would be made by the use of the water of condensation. The economy of the steam turbine is more susceptible to vacuum than a reciprocating engine. The fraction of an inch reduction in the vacuum means a considerable increase in the pounds of water per horse-power hour. The principal cause of leaky condensers is pitting. A number of means for preventing this has been tried, but no one has been wholly successful. In some of the large power stations boosters are used, and in nearly all power stations different kinds and mixtures of metals have been tried, but without success. Where water is not very expensive, I would advocate the installation of a jet condenser, but where water is as expensive as $1.00 per 1000 cubic feet, I would recommend the installation of surface condensers, and entertain the hope that a remedy for the trouble experienced with them will be found before very long.—Alfred Green, Brooklyn, N. Y.

The use of jet condensers on a turbine installation depends on the volume of water available for the condenser. If the question of the boiler feed water and particularly the water for the condenser is important, the surface condenser is by far the best; otherwise the jet condenser would be just as satisfactory and much cheaper.—Knoxville Railway & Light Company, Knoxville, Tenn.

Q. 2.—Have you had any trouble with stripping of blades in a turbine of either the Parsons or Curtis type? If so, to what did you lay the cause? What do you suggest as a remedy?

No trouble. Operating fifteen months.—Auburn & Syracuse Electric Railway Company, Auburn, N. Y.

Have had no trouble from stripping blades. Our turbines are of the Curtis type.—Little Rock Railway & Electric Company, Little Rock, Ark.

We have partly stripped the blades from two 2250 horsepower Parsons turbines. Cause, exceptionally long spindle, flexibility, distortion and an imperfect balance. Remedied with a shorter spindle.—Ft. Wayne & Wabash Valley Traction Company, Wayne, Ind.

Have run two 500-kilowatt Curtis turbines thirty months and have had no trouble with the blades.—Rockland, Thomaston & Camden Street Railway Company, Rockland, Me.

Never stripped a blade.—Greenville Traction Company, Greenville, S. C.

Never. Curtis used.—The Columbus Railway & Light Company, Columbus, Ohio, C. C. Collins, assistant general manager.

We have had blades stripped from the Curtis turbine caused by failure of the step bearing.—Knoxville Railway & Light Company, Knoxville, Tenn.

Q. 3.—Have you had any trouble caused by deposits of foreign matter forming on the blades of the turbine? How do you remedy this?

No. Use condensed water for sealing glands.—Auburn & Syracuse Electric Railway Company, Auburn, N. Y.

We have had no trouble by deposit of foreign matter on the blades of the turbine. Have had considerable deposit due to gland water in the gland and on the ends of the spindle. Remedy: A cistern with treated or soft water in connection with a cooling tower.—Ft. Wayne & Wabash Valley Traction Company, Ft. Wayne, Ind.

Steam as dry as possible should be used, and care should be taken to see that the proper kind and amount of boiler compound is used. With the superheated steam there should be practically no deposit on the blades or vanes of the turbine: Leaky condensers, causing the percentage of salt in the boiler feed water to be high, may be responsible for some of the deposit that has been found in turbines.—Alfred Green, Brooklyn, N. Y.

Q. 4.—What success have you had with motor generators wound for 6,600 to 16,000 volts on the alternating current side? Is any difficulty experienced due to direct exposure of windings to lightning?

We have operated 13,200-volt generators for four years and have had no breakdown or disturbance from lightning.—Ft. Wayne & Wabash Valley Traction Company, Ft. Wayne, Ind.

With a proper lightning arrester I think no great difficulty need be experienced with motor generators wound for 6000 to 16,000 volts on the alternating current side.—Alfred Green, Brooklyn, N. Y.

Q. 5.—What is the smallest size of boiler plant or minimum coal consumption which warrants the use of automatic stokers?

Depends on cost and kind of coal used.—Auburn & Syracuse Electric Railway Company, Auburn, N. Y.

A plant consuming 30 tons of coal in eighteen hours, developing its rated boiler horse-power, should be equipped with stokers.—Ft. Wayne & Wabash Valley Traction Company, Ft. Wayne, Ind.

About 2000 horse-power with one boiler in reserve for hand firing for peaks.—The Calumet Electric Street Railway Company, Chicago, Ill.

Twelve hundred horse-power.—Green Bay Traction Company, Green Bay, Wis.

My choice is 1000 horse-power, but a Caldwell shovel is economy on a single boiler.—Greenville Traction Company, Greenville, S. C.

Would say that the smallest boiler plant on which automatic stokers would pay would be in the neighborhood of 4000 horse-power.—Knoxville Railway & Light Company, Knoxville, Tenn.

Q. 6.—Is it advisable to use gaskets for superheated steam headers?

It is better to use ground joints for superheated steam headers.—Little Rock Railway & Electric Company, Little Rock, Ark.

The ground joint, I think, is preferable to a gasket on a superheated steam header.—Alfred Green, Brooklyn, N. Y.

No.—Greenville Traction Company, Greenville, S. C., H. R. Fothergill, general manager.

Would advise corrugated copper gaskets on superheated steam headers.—Knoxville Railway & Light Company, Knoxville, Tenn.

Q. 7.—In a small or medium size plant, what is the best method of increasing boiler capacity during heavy peak loads? Give details and results obtained.

We think induced draft. Just about installing an outfit.—DeKalb-Sycamore & Interurban Traction Company, DeKalb, Ill.

Have been using the Parsons' system of furnaces in two plants to increase boiler capacity with very good results, obtaining 25 per cent. to 40 per cent. more steam from boilers than with hand fire. This system was installed to carry us over the peak load, otherwise we would have had to purchase more boiler capacity and have bought more land for boiler room. We have got as much as double rating from boiler with clean boiler and clean fires, the only requirement being that boiler be kept clean so as not to lose tubes.—Lynchburg Traction & Light Company, Lynchburg, Va.

Increase the grate area. The output of the boiler depends very largely upon the amount of coal that can be burned, which in turn, the draft being good, depends on the grate area. In power station work it is, therefore, of great importance to have a large grate area. While forcing a boiler in this way will necessarily give a high flue temperature, the losses thus caused are not great and only last for a comparatively short time.

In a medium-sized plant where No. 3 buckwheat coal, or a mixture of No. 3 buckwheat and soft coal are burned, the capacity of the boilers can be considerably increased by increasing the percentage of soft coal in the mixture and still make very little smoke. With a mixture half and half of No. 3 buckwheat and soft coal at least 175 per cent. rating can be obtained with less than 2 ins. of air under the grates.—Alfred Green, Brooklyn, N. Y.

By blowing superheated steam and air at bridge.—Greenville Traction Company, Greenville, S. C.

Q. 8.—What schemes are there for inducing firemen to take greater interest in their work? Please give details and results obtained.

CO_2 recorder.—Auburn & Syracuse Electric Railway Company, Auburn, N. Y.

Have a chief engineer with a full cargo of sand. If he lacks that element, go into the boiler room yourself and demand that a 6-in. to 8-in. clean level fire be run; see that the water is kept nearly constant in the boiler; see that these points are carried out to the letter. After one week of this work in the fire-room, the firemen and engineers will see that they have been in the ruts and will be so astounded by the results that they will afterwards try hard to make a good showing. Get the firemen interested to produce a good pressure card.—Rockland, Thomaston & Camden Street Railway Company, Rockland, Me.

Several electric railway companies have put in force a premium system for power house employees. The Sheboygan Light, Power & Railway Company, of Sheboygan, Wis., has reduced the cost of generating power through the means of a premium system. Taking the cost of power at 1.1 cents per kilowatt-hour, which was the average cost before the premium system was started, the company each month divides among the station employees 10 per cent. of the saving whenever the cost per kilowatt-hour for any one month drops below that amount. The division is made according to rank, the engineers receiving the largest amount and the oilers the lowest. The company is paying out in premiums $40 to $80 per month, indicating a saving in power station expenses of $400 to $800 per month. The company states the adoption of the bonus system has brought about a marked improvement, not only in the cost at which power is produced, but in the service in general as well. Every man not only tries to do his best, but also helps the others to do their best. Engineers watch the firemen to see that the coal is economically burned, and the firemen protest if the engineers run the larger units at low power factor instead of putting in smaller units. Every employee is on the watch for hot bearings, which would mean costly repairs, and carelessness in one employee will not be tolerated by the other.

Simply watching and checking them.—Green Bay Traction Company, Green Bay, Wis.

By having frequent evaporated tests, considerable rivalry can be developed among the firemen, also by posting in the boiler room the name of the fireman who can evaporate the most water with the least amount of coal and have the smallest amount of combustible matter in the refuse. It could be understood that the man making the best showing will receive the next position at water-tender. The CO_2 recording apparatus can be made good use of by posting the record made by different firemen in the boiler room.—Alfred Green, Brooklyn, N. Y.

Q. 9.—How can coal fires be prevented?

Have the cold storage bins built with concrete walls between them so that only a small portion of the coal pile can burn at a time.—Little Rock Railway & Light Company, Little Rock, Ark.

By sufficient ventilation to keep the temperature below the combustion point.—Fort Wayne & Wabash Valley Traction Company, Fort Wayne, Ind.

Prevent pockets from forming around wood, especially around trestle uprights. Have tried 3.5-in. boiler tubes in a pile of 2300 tons, but did not prevent fire. The tubes make it convenient to take the temperature and to flood the coal piles with water.—Rockland, Thomaston & Camden Street Railway Company, Rockland, Me.

Coal containing sulphur is apt to ignite spontaneously. Such coal should not be piled deep and should be closely watched. Vertical tubes, say, old boiler tubes, placed in the pile, give an opportunity to test the temperature of the pile by means of thermometers. Keep down size of pile and take coal from centre or deepest part.—Green Bay Traction Company, Green Bay, Wis.

If soft coal is to be stored, it should be done when the coal is dry, and it should be stored on a dry foundation. The coal should not be dropped from any great height as the friction generates heat, and it is a fact that coal dropped from great heights is much more liable to spontaneous combustion than where it is thrown up on the pile or dropped from a low elevation. It is not advisable to store coal to a height of over 20 feet. When coal is stored to any great height the pressure at the bottom of the pile is so great that the fire is easily started. In storing soft coal, care should be taken not to mix coal from different mines, and not to mix anthracite and soft coal. It is advisable to provide as much ventilation as possible.—Alfred Green, Brooklyn, N. Y.

Keep coal dry.—Greenville Traction Company, Greenville, S. C.

ENGINEERING IN A NUTSHELL

Answers to Questions That Won First Prize in the Michigan N. A. S. E. Contest

By Edward J. Rose.

Subject No. 5.—Taking Charge of a Steam Power Plant.

The reliable engineer is nearly always a man of thoughtfulness, and in taking charge of a steam power plant with its important responsibilities, he realizes that he is taking charge with an almost independent trust of property and life. His quickness of apprehension will enable him to make proper deductions and reason logically. He will at once make himself familiar with the boilers and attachments, including all pump and piping. He will find out the smallest details to ascertain the practical workings of them. He will continue his close observation throughout the plant, and after this thorough examination, if he finds any part in bad condition, caused by neglect or inattention by the former engineer, it will be a duty to himself and employers to report the facts. He can then assume direct charge of all the boilers and machinery. If he finds that there is much work to be done in the way of stopping leaks or pounding engines, it will be advisable to search for the trouble and not attempt to remedy it too soon, but repair them, until you have gone over all the defects.

The next thing to be done is to see that the plant is economical in its operation. This is where the engineer comes in contact with all the smallest and largest details, minutely inspecting each individual part of the plant. He should exercise his authority with caution and deliberation, and must never overestimate his own ability. Assisted by his previous experience, he will in a very short time feel right at home with his new position.

Subject No. 6.—The Safe Working Pressure of Steam Boilers.

To find the safe working pressure that a boiler shell will carry, multiply one-sixth of the lowest tensile strength found stamped on any plate in the cylindrical shell by the thickness expressed in inches or parts of an inch of the thinnest plate in the same cylindrical shell, and divide by the radius or half the diameter—also expressed in inches—and the result will be the pressure allowable per square inch of surface for single rivetings, to which add 20 per cent. for double rivetings. For an iron boiler we should take 40,000 pounds as a tensile strength, because that is the lowest strength of iron used in construction of boilers; 50,000 pounds is the highest. For steel boilers we would use 50,000 pounds of tensile strength, because that is the lowest tensile strength of steel used in the construction of boilers—65,000 pounds is about the highest.

The above rule covers the question when the exact strength of the joints are not known. We find in double-riveted joints, an accession of strength over the single riveted joints of nearly 20 per cent. This arises from the wider lap and the better distribution of material. The rivets are pitched wider and there is more rivet area to be sheared, together with a larger percentage of net section of plate to be broken.

The strength of a joint can be determined only by careful calculation, and in figuring the safe working pressure of a steam boiler we must keep within the bounds of safety.

Now let us take a boiler 60 in. in diameter, made of ⅜-in. steel plate, with a tensile strength of, say, 60,000 lbs., and we will apply the above rule to get the safe working pressure. It has a triple riveted joint with ¾″ rivets driven in 13-16″ holes pitched 3¼ in—$3.25 \times 0.375 \times 60{,}000 = 72{,}125$ lbs., strength of solid plate; $3.25 - 0.8125 \times 0.375 \times 60{,}000 = 54{,}843$ lbs., strength of net section of plate; $0.5185 \times 3 \times 38{,}000 = 59{,}109$, strength of three rivets in single shear; $3.25 - 0.8125 \div 3.25 = 75$ per cent. efficiency of joint; $0.375 \times 60{,}000 \div 30 = 750$ lbs., solid plate will burst at $750 \times .75 = 562$ lbs., this the seam will burst at.

All boilers should be placed on a factor of safety no less than 5 or 1/5 of $60{,}000 = 12{,}000$; so the safe working pressure is $= 0.375 \times 12{,}000 \times 75 \div 30 = 112\frac{1}{2}$ lbs. The margin of safety should be greater in an old boiler than in a new one.

Subject No. 7.—Selection of Apparatus.

The efficiency of any plant depends primarily upon its mechanical equipment. This being true, it is of the greatest importance to install the proper sort of machinery and manipulate it to the best advantage.

As regards the selection of a steam engine, the conditions to be dealt with must be gone over carefully, and then the most important thing, after deciding the size, is the economy of operation (an engine that will produce a horse-power at the lowest ultimate cost per year, including coal, attendance and maintenance). It is a well-known fact among up-to-date engineers that the throttling single-cylinder engine, exhausting to the atmosphere, requires 40 to 65 lbs., of steam per horse-power per hour. Of course, it has the advantage of the lowest first cost, but an engine of that type would not be considered for anything that requires more than 10 horse-power.

The next type is the automatic shaft governor, and we find that that requires 30 to 35 lbs. non-condensing and 25 to 30

with a condenser, while with a Corliss, with its four valves, will require only 23 to 28 non-condensing, and as low as 19 lbs. condensing.

Now let us see what we would gain by putting in a four-valve engine in place of an automatic slide-valve engine.

We will take the automatic engine first, and we will say that it is doing 300 horse-power for 10 hours, and our boilers are evaporating 8 lbs. water per pound of coal, and our engine is using 35 lbs. steam per horse-power per hour. So we have $300 \times 35 \times 10 \div 8 = 13{,}000$, or 6.55 tons, which, at $3.00 per ton, would be $19.65.

Now we will take the four-valve engine at the same horse-power per hour and using 25 lbs. steam per horse-power per hour, and boilers evaporating 8 lbs., same as above, and we have $300 \times 25 \times 10 \div 8 = 4.67$ tons, which, at $3.00 per ton, would be $14.06, a net saving of $5.59, and if we run 10 hours a day for 313 days, we would have a net gain of $1,749.67 in one year; so let our selection be a four-valve engine. It must be one that admits the steam to the cylinder promptly at the beginning of the stroke, and at full boiler pressure this requires steam passages to be short and large, and the supply of steam must be shut off without wire drawing, and the steam within the cylinder allowed to work expansively until the end of the stroke. A high piston speed is required, so that the steam will do its work quickly and not transfer the heat to the cylinder walls.

The governor should have perfect gravity balance and free from excessive friction, simple and easy to adjust, and have all parts of the engine tooled to standard gauges, and each part interchangeable with all others, and all bearings must afford ample means for the compensation of all wear.

In making this selection we must avoid the mistake frequently made in considering the first cost of the plant as of the first importance, and that any saving in this direction as so much gain. Money borrowed from the power plant to put into the factory, is borrowed at a ruinously high rate of interest and with no chance of repayment, except by throwing out the cheap plant and substituting the more economical one at great expense; so if the engine is to be selected for a new power plant, the Corliss engine is the only one seriously considered for plants from 100 horse-power up, in which it is desired to obtain highest economy.

SUBJECT NO. 8.—PLANS AND SPECIFICATIONS OF A STEAM BOILER.

Size of Boilers.—The shell of the boiler shall be sixty (60) inches diameter and fourteen (14'-0") feet long. No dome will be required, but the boiler shall be provided with suitable pan or perforated dry pipe at least seven (7") inches in diameter and seven (7') feet long, or a compound dry pipe.

Pressure.—The boiler shall be built for operation with steam pressure of one hundred and twenty-five (125) pounds per square inch gauge pressure.

Tubes.—The tubes shall be at least fifty-four (54) in number, and three and one-half (3½) inches in diameter, and shall be of the best quality mild steel, annealed at both ends. All tubes shall be tested to, at least, 200 lbs. hydrostatic pressure at the tube mills. The tubes shall be laid out in vertical and horizontal rows four and one-half (4½) inch centers, except central vertical row, which shall be five (5) inches center to center. The spacing shall be subject to approval.

Manholes.—The boiler shall be provided with two manholes of the eclipse pattern, one in the front head below the tubes and one in the top of shell near the rear end, and shall be approximately 11 x 15 inches in size.

Shells and Heads.—The boiler shells shall be three-eights (⅜) inch thick and the heads shall be nine-sixteenths (9/16) inches thick. All boiler plate shall be of the best quality homogenous open-hearth steel; each sheet to be legibly branded with the name of the maker and with the quality of steel and so rolled that the stamp marks will be on the outside. Each sheet shall be tested, and shall show not less than 55,000 or more than 62,000 tensile strength, and not less than 50 per cent. reduction in area, or less than 25 per cent. elongation in eight (8) inches. Test pieces must also stand being bent cold through 180 degrees and hammering flat without signs of fracture. Heads shall be of the same quality of steel as the shell, and shall be 9/16 inch in thickness, and have the maker's name and quality of the steel stamped on the outside. The flanges shall be bent in a neat manner to an internal radius of two (2) inches, and shall be free from flaws, checks or defects of any nature. All tube holes shall be drilled and not punched.

The contractor shall also furnish to the architects a certified copy of the maker's tests of the plates used in the construction of this boiler. The shells shall be made in two courses, each sheet being long enough to form the entire circumference of the boiler without piercing and to bring the horizontal seams well above the fire line.

Manhole Heads.—The heads for the manholes shall be made of pressed or cast steel plate ¾" thick, and shall be secured by two steel crabs or yokes and one set of best quality gaskets.

Rivets and Caulking.—All rivet holes shall be punched 1/16 inch smaller than rivets, and shall be reamed to size after sheets have been rolled and bolted together. The holes not to come nearer the edge of the sheet than 1⅛ inches. All rivets for shell heads and flanges shall be 13/16 inch in diameter and of the best quality of refined iron, equal to (Burdens Best) and to be long enough to form up heads equal to pressed heads to be driven so as to completely fill the holes, and the heads to be driven down smooth without offset to one side.

The horizontal seams of shell shall be double butt, strapped with three rows of rivets each side of seam. The inside strap shall be 15⅝ inches wide, and the outside strap 9¾ inches wide. Both straps to be made the same thickness and quality as the shell. The pitch of the rivets in the four inner rows shall be 3⅜ inches and in the two outer rows 6¾ inches, the distance between the first row, between the first and second row and between the second and third row shall be 2 13/16 inches, 2¼ inches and 2¾ inches respectively. The straps shall be long enough to take in the girth seams at either end which shall be single riveted with a pitch of 2¾ inches between rivets. All sheets and straps shall be planed level before rolling and riveting shall be caulked with a concave tool so as to entirely avoid cutting into the under sheet.

Bracing and Staying.—All braces shall be of the best quality refined iron or mild steel and shall not be subjected to more than 7,500 lbs. per square inch tensile strain. All stays shall be of the double crow foot pattern.

Tubes.—Shall be carefully expanded with a dudgeon or other roller expander, and shall be well beaded over at either end without check or flaws.

Cast Iron.—No cast iron will be permitted in any part of the construction of this boiler.

Flanges.—This boiler shall be provided with the following steel flanges, with reinforcing plates ⅜" thick on inside of boiler shell for steam supply and safety valve: One threaded steel flange for 6" pipe for steam supply about 4 ft. 0" from front head; one threaded steel flange for two (2) inch pipe for feed water inlet 1' 6" from rear head; one threaded steel flange for two and one-half (2½) inch pipe riveted to the bottom of the boiler one foot (1') forward of the rear head for blow-off connection; one threaded steel flange for one and one-quarter (1¼) inch pipe and riveted to top of boiler, and one and one-quarter (1¼) hole tapped in front head near bottom for water column; one two and and one-half (2½) inch threaded steel flange for flue blower. Injector and pump connections about two (2) feet from front head. All flanges to be threaded and caulked.

Water Column.—This boiler shall be provided with one No. 6 Wright or Reliance water column with low water alarm. The water column connection shall be provided with three of the best quality

spring compression gauge cocks and sufficient length of nickel-plated plumber's chain and substantial handles to operate valves from floor of boiler room.

This water column shall be provided with three-fourths (¾) inch water glass connections having four guards. All water column trimmings shall be nickel-plated. The water glass shall be provided with Jenkins automatic water glass cocks. The water column shall be provided with two extra heavy one and one-quarter (1¼) inch brass body gate valves and the proper pipe and fittings for connection to the boiler. Brass plugs shall be provided to allow cleaning of water column pipes.

Steam Gauge.—Boiler shall be provided with one eight and one-half (8½) inch dial double tube (lane) steam gauge graduated to two hundred (200) pounds, and shall be provided with a nickel-plated brass case and with lever-handle, drip cocks with brass, nickel-plated siphon.

The gauge shall be "American" or other aproved make equally as good.

Safety Valves.—This boiler shall be furnished with one 3½" spring loaded pop safety valve set—95 lbs. pressure per square inch and adjustable for any pressure up to 130 pounds per square inch. This valve shall be of the "American" or other approved make.

Blow-Off Valves.—One two and one-half (2½) inch Lukenheimer or other approved make angle blow-off valve, and also one two and one-half (2½) inch extra heavy asbestos packed, blow-off cock shall be furnished for this boiler.

Stop and Check Valves.—The boiler shall be provided with one two (2) inch extra heavy horizontal brass swing check and one two (2) inch extra heavy brass gate valve.

Fixtures.—This boiler shall be provided with full ornamental cast iron front at least one-half (½) inch in thickness, with anchor bolts and all necessary fire doors, ash doors, cleaning doors, etc., rear arch bars and supports for combustion chamber.

The boiler shall be provided with four (4) substantial ribbed pressed steel wall brackets two on each side of heavy pattern and to be not less than twelve (12) inches wide, twelve (12") inch projection and twelve (12") inches on the shell of the boiler with six seven-eighth (⅞) rivets above the horizontal part and three below. Cast iron plates on which the brackets are to rest shall also be furnished and three rollers, one inch diameter, 10 inches long for each rear lug. Also extra heavy wall bending bars and the tie bolts to extend through the setting and bending bars.

Cleaning Doors.—There shall also be provided for this boiler one cast iron clean-out door 16" x 21" in size with door frame and rods for proper fastening in brick setting.

Grates.—The boiler shall be provided with all grate bearers, dead plates, etc., necessary to completely equip the fire box, including a complete set of shaking grates of approved make.

Fire Tools.—With the boiler shall be furnished a complete set of fire tools consisting of a hoe, rake, No. 8 shovel, slice bar and flue cleaner.

Testing and Inspection.—The boiler shall be inspected and tested at the boiler works before shipment, and the contractor shall notify the architects when the boiler is ready for test, so they or other duly accredited person may be present.

The boiler shall be tested to a Hydrostatic pressure of 185 pounds per square inch, and made tight at that pressure, and shall be subsequently examined internally and externally by an inspector, and if found to comply with the above specifications a working pressure of 125 pounds per square inch will be allowed.

THE ALIGNMENT OF ENGINES

Methods of Ascertaining if the Crank is Working at Right Angles to the Shaft

After a new engine has been placed upon its foundation, or in cases where new bearings have been put in the engine, it is often necessary to find out if the crank is working in a plane exactly at right angles to the shaft. If this condition is not exactly attained there will generally be trouble of some kind in the cross-head, crank-pin or main bearing boxes.

The most simple engine to align is the center crank engine in which the two bearings are directly mounted on the bed plate

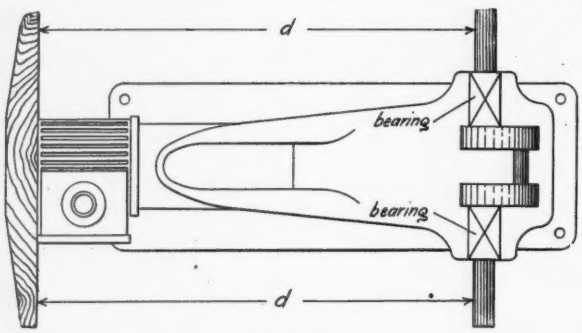


Fig. 1.

and the fly-wheel overhangs the bearings. Side crank engines, however, usually have an independent bearing, and it takes some ingenuity to correctly adjust this bearing to the proper position so that the shaft will be horizontal and exactly at right angles to the center line of the engine.

When it is necessary to line up a center-crank engine, it may be tested to see that the shaft is square with the centre line of the engine, as follows: Place a true straight-edge across the planed cylinder face, as shown in Fig. 1, and measure from it to the surface of the shaft at each side of the shaft. These distances, d d, should be equal, if both ends of the shaft are the same diameter. The longer the shaft and straight-edge, the more accurate can these measurements be made, because the measurements can be made farther apart.

In the side crank engine, if the outer bearing is too high or too low, it will force the crank to revolve in a plane, making an angle with true plane of revolution, which will twist the rod each stroke. If the outboard bearing is out of place in both planes, the rod may be both twisted and bent. The proper methods of aligning the outer bearing involves finding the true axis of the cylinder of the engine.

After having removed the connecting rod, cross head, back cylinder head and piston from the engine, stretch a piece of strong linen thread or fine piano wire through the bore of the cylinder and stuffing-box, and fasten it to two fixed points. Before doing this, however, be sure that the engine is level on its bed. The wire should then be centered in the cylinder, which should be done with considerable care.

If it is not convenient to find two fixed points on either side of the engine, then one end of the cord can be fastened to a bar which is bolted on the end of the cylinder, and the other end can be fastened to an iron rod, which should be fastened to the floor. The cord should then be centred in the cylinder. A piece of wood slightly less in length than the radius of the counterbore may be used, with a pin or piece of light metal stuck in the end to make up the exact radius. The line should then be adjusted in the cylinder so that the gauge will lightly touch

the line from four points of the counter-bore. It will be noticed that the counter-bore is used rather than the cylinder, because the latter may have been affected by wear. After having centered the line at the head end of the cylinder, it should be centered at the stuffing-box end, not from the stuffing-box, which may also be out of round, but from the counter-bore on that end.

After the line is truly centred, the guides may be examined

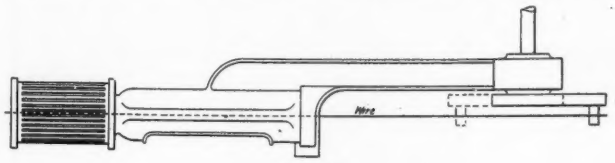


Fig. 2

to see that they are in line. With many types of engines which have bored guides, or guides which are part of the frame, this may not be necessary, but with the four-bar type of guide it would be advisable to see that it was in line with cord stretched through the cylinder axis.

To adjust the outboard bearing, turn the shaft until the crank, in coming toward the inner dead center, touches the cord. It will touch it at a certain distance from the end of the crank pin. The shaft may be then turned over until the crank pin, approaching its outer dead center, touches the cord again. It will only touch it at an equal distance from its end, or some fixed point, when the shaft is revolving around an axis truly at right angles to the cord. If the shaft shows "out," the bearing should be adjusted, horizontally, until the cord cuts the crank pin at the same point and in the same plane, on its outer and inner centers, as shown in Fig. 2.

The adjustment of the shaft in a horizontal plane may be effected by a sensitive level; but a more sensitive and satisfactory adjustment is made by putting the crank pin 90 degrees form its dead center and holding a plumb-line so as to touch the pin and cord, and noting the distance the plumb-line is from the end of the crank pin, as shown in Fig. 3. If the plumb-line touches the crank pin at the same point that it

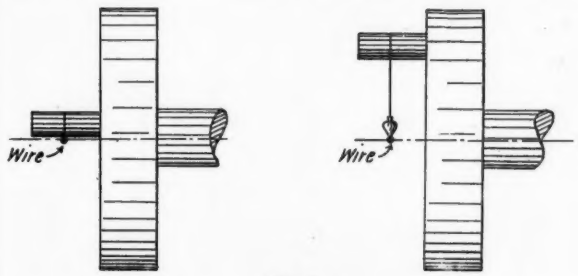


Fig. 3

touches it when the pin is half stroke below the wire, then the pin is turning in a vertical plane.

If adjustment is required in either planes, the usual procedure is followed of correcting half the error and testing the alignment again. The outer bearing often rests on a plate which has provision for adjustment, but very often the vertical adjustment is made by shimming or filing.

The alignment of vertical engines is usually simpler than that of horizontal engines, because the bearings are always on the bed-plate and have been machined and aligned properly before leaving the erection shops. Should, however, it become necessary to make adjustments, a wire should be centered through the cylinder, and if the engine is set exactly vertical, the cylinder walls will be parallel and the top of the cylinder square with it. The guides should also be parallel to this line, and a line drawn through the center of the main bearings will show if the engine is square.

The proper alignment of an engine is delicate work, and it requires considerable skill and experience to be able to realize the great amount of accuracy required, especially in centering the line in the cylinder.

Having the engine lined up, the different parts must be assembled and the proper clearance allowed in each end of the cylinder. The engine should be put on the center by the tram method as shown in Fig. 4. This is done by turning the engine forward until the crank is 15 or 20 degrees from the center. Make a scribe mark A on guide and cross-head. Make a punch mark B on the engine frame near the crank disc, and from this point with a tram make a mark C on the disc. Turn the engine over until marks A on the guide and cross-head again coincide. With the same tram, and from the punch mark B, make a second mark D on the disk. Divine the distance C D with a pair of dividers and put a punch mark E half way

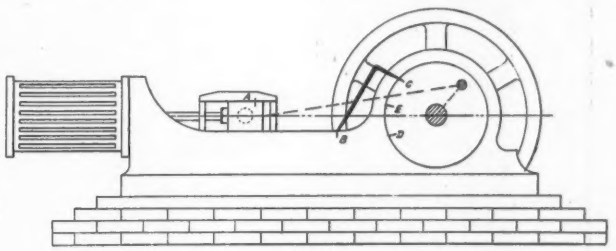


Fig. 4

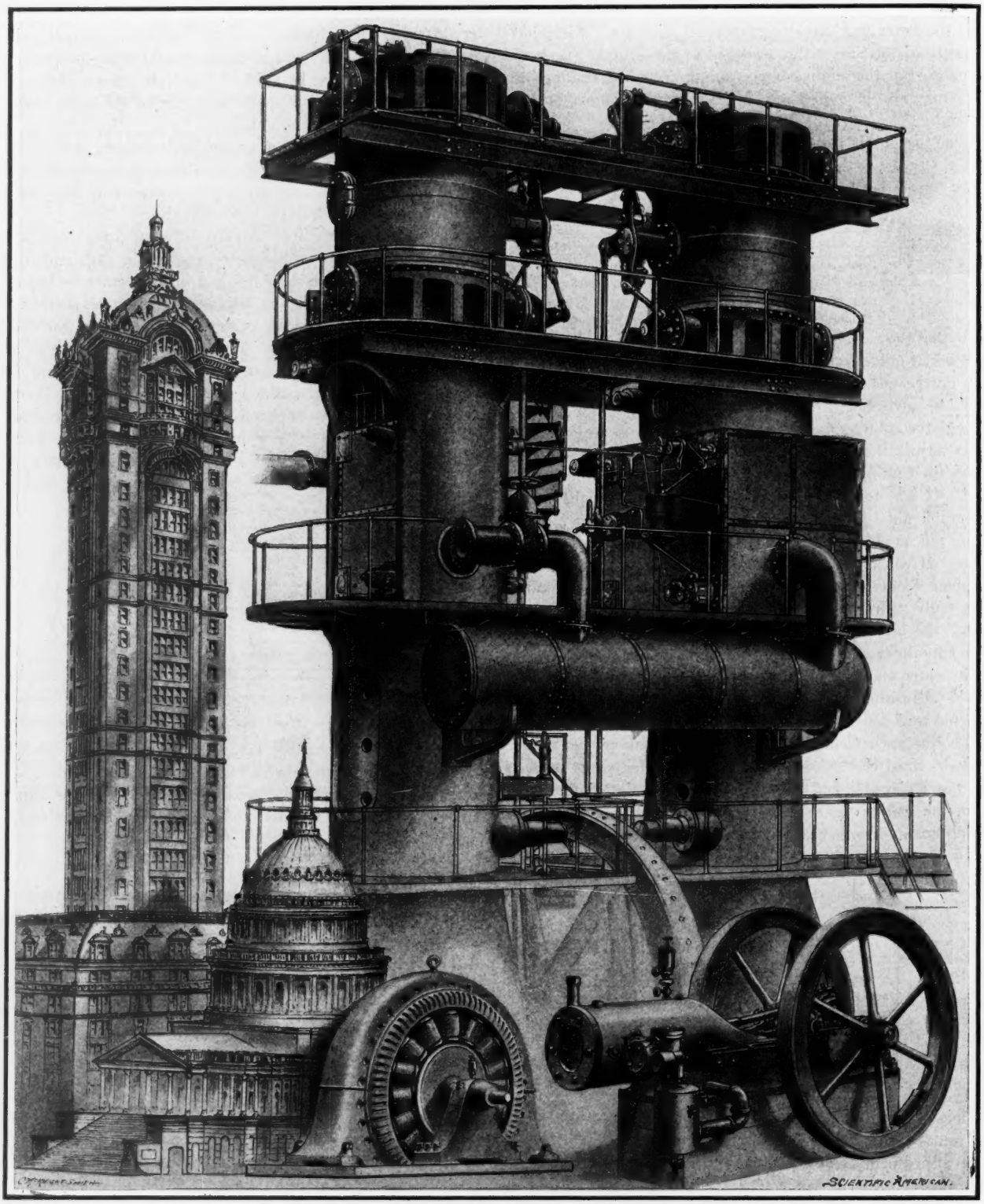
between them. Turn the engine until the trams just fit the distance B E, and the engine is on center. The piston rod can then be screwed into the cross-head, the clearance adjusted for both ends, the valve set, and the engine should be ready to run.

Gasoline Three Times More Economical than Alcohol.

In one of the recent tests made at the United States Geological Survey fuel-testing plant at the Jamestown Exposition to determine the relative fuel value of alcohol and other liquid fuels, it was found that it took one and a half gallons of denatured alcohol to produce as much power as a gallon of gasoline. Since alcohol costs about twice as much as gasoline, the economical power value of the gasoline is three times greater than alcohol, according to these tests.

Oil for Air Compressors.

Since there is no washing tendency in air cylinders, as there is in steam cylinders, a very little oil will last a long time. The oil used, however, should be of the best quality obtainable and of a high flash point. It should be a non-coking oil; that is, when the oil is evaporated, it should not leave a deposit of carbon. In general figures, about one-quarter the amount of oil used in steam cylinders will be found to be good practice for air compressors.



GRAPHIC REPRESENTATION OF THE ENORMOUS ENERGY EXPENDED IN MANUFACTURES IN THE UNITED STATES.

The total steam power employed in manufactures in the United States in 1905 was 10,664,560. A single steam engine of this power would measure 400 feet by 255 feet on the base, and would extend 735 feet into the air, or 123 feet above the Singer building. To develop the total electrical horse-power of 1,138,208 would call for a generator with a 134-foot base, and 126 feet high. The total of 289,514 gas engine power would require an engine 350 feet long by 80 feet high.

Enormous Power Consumed in Our Industries.

The accompanying illustration gives a graphic representation of the enormous total of horse-power which is required to run the industrial establishments of the United States. The drawing is based upon the latest available statistics on this subject, which are to be found in the report of the United States Census Bureau for the year 1905. The mere statement of figures which run into the millions conveys to the mind of the average layman no adequate idea of the quantities involved; and particularly is this true when applied to such a subject as total aggregates of engine horse-power. But when these figures are translated into concrete forms, they begin to take on intelligible meaning. Everyone is more or less familiar, either through the medium of illustration or through a visit to an actual plant, with the general appearance and the great proportions of the typical steam engine of large size used in modern power plants, whether for electric lighting, or power, or for providing the necessary air for blast furnaces. So also the general appearance of a typical gas engine, or of an electrical generator, is more or less familiar; and in this illustration the total number of units of steam engines, gas engines and electric generators are supposed to be thrown into one, and the resulting dimensions of the single unit, thus obtained in each case, is depicted, with the great Singer tower shown in the group for comparison.

The results are certainly very striking. If the 10,664,560 steam horse-power used in our industries were represented by a vertical cross-compound blowing engine, of the kind that is used in our blast-furnace practice, we would have a huge affair, whose base plate would cover one-half of a large city block, and the top of whose topmost cylinders would tower 735 feet skyward. The tallest building in the world to-day, the tower of the Singer building, is 612 feet in height, so that this monster engine would overtop the great building by 123 feet. Similarly, if the total electrical horse-power of 1,138,208 were to be represented by a single generator, we would have to build a machine whose base would measure 134 feet in length, and whose highest point would be 126 feet above the ground. The great proportions of this machine are shown by comparing it with the dome of the Capitol at Washington. To develop the total of 289,514 gas-engine horse-power, would call for an engine 350 feet in length by about 80 feet in height from the base plate to the top of the cylinder.

The census figures showing the growth of total horse-power by decades since 1870 are of great interest. In addition to those which we have illustrated, there is a total of 1,647,969 water-power, 91,784 miscellaneous horse-power, and 632,905 rented horse-power. The grand total for the whole United States is 14,464,940, as compared with a total of only 2,346,-142 horse-power in the year 1870. In 1880 the total had risen to 3,410,837, an increase of 45.4 per cent. From 1880 to 1890 the total grew to nearly 6,000,000 horse-power, an increase of 74.6 per cent. The same percentage was maintained from 1890 to 1900, when the total had risen to 10,409,625 horse-power. It will thus be seen that the greatest actual relative increase occurred between 1890 and 1900; and, notwithstanding the great increase in other kinds of power, steam has continued to be the motive power of greatest importance, representing in 1870, 51.8 per cent. of the total horse-power employed in manufactures; in 1880, 64.1 per cent.; in 1890, 76.9 per cent.; in 1900, 78.2 per cent., and 73.7 per cent. in the census of 1905. One of the most notable features of the development of machinery in manufactures has been the growth of the use of the electric current for the transmission of power. The first census to show electric power was that of 1890, when only 15,569 horse-power was reported. Fifteen years later this had grown to 1,138,208 horse-power. It should be noted, in connection with the above statistics, that when the electric power is generated by the manufacturer, the combination of the horse-power of the engines and the motors results in a duplication; but since in some cases the steam engines are used for purposes other than the generation of electric current, it is impracticable to avoid this duplication.

In conclusion, we would draw attention to the fact that this engraving shows the day to be very far distant when the steam engine is to be relegated to a subordinate position, and the lead taken either by electricity or gas.—*Scientific American.*

———o———

Anthracite Coal Centennial.

Appropriate celebration of the centennial of anthracite coal is being considered by the citizens of the town of Plymouth, Pennsylvania. In 1807 the first shipment of the "black stone" was made by boat down the Susquehanna River, from Plymouth to Columbia, Pa. This date marks the beginning of the use of anthracite, which, according to records of the United States Geological Survey, was discovered about 1790, but was burned only by the use of blowers and forced draught before 1807.

It was the discovery that anthracite must be freed from every impurity and crushed to a uniform size before it could be successfully burned, which started the great industry that this year will probably have an output of 70,000,000 tons.

People had become accustomed to burning soft coal which contained so much gas that lumps of any size could be burned without difficulty. Few would have predicted, that unlike soft coal which is sent to market as it comes from the mine, hard coal would require preparation for market almost as complicated as the manufacture of flour from wheat.

The actual mining of anthracite is only the beginning of a long series of processes which produce the accurately-sized pure coal which is so satisfactorily burned to-day in millions of homes, and in heating plants of large buildings which must have smokeless chimneys. As it comes from the mines anthracite varies in size from lumps as large as a waterlemon to those as small as a walnut. The large lumps are individually examined on benches, by men who are expert in detecting layers of black slate or other impurities which look just like coal and which are unavoidably mined with it. With small axes the lumps are cracked, and the unburnable material removed before the coal is passed on to be crushed and sorted, by passing over moving screens, into the numerous sizes ready for loading on the cars.

Lumps too small to be separately inspected on the start are crushed first and screened into uniform sizes, after which boys pick out all the impurities as the coal passes slowly in thin layers down long chutes. In some localities considerable dirt adheres to the coal, and in addition to the crushing and sizing, it is necessary to subject it to several washings during preparation so that it will be clean and bright, and impurities can be readily seen and removed.

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Electrification of Steam Roads and the Stationary Engineer

The increasing number of railroads which are equipping their lines with electric traction calls attention to the fact that the number of large central station power houses being erected for this purpose has opened an increased field for the stationary engineer. Should the dream of the electric traction advocate come true, no more will the puffing locomotive throw out its smoke along the landscape, but instead the silent motor car will wend its way over the hills and through the valleys. Already interurban electric transit is universal in this country and with the electrification of the trunk lines, which is taking place on the Pennsylvania, New York, New Haven and Hartford, Spokane and Inland, Southern Pacific and other railroads, the utilization of universal electric traction is becoming nearer.

Among the many points in favor of the electric locomotive as against steam locomotives, aside from the smoke nuisance, are, that the electric locomotives will give an increased horsepower with increased load up to the point of slipping of the wheels, whereas the steam locomotive develops its maximum power at high speeds, and consequently in starting large loads and ascending grades, the locomotive is working at reduced output and reduced efficiency. Two or more electric locomotives may be operated as a single unit when required without increasing the train crew. The electric locomotives obtain the benefit of a centralized power house and its consequent economy. All the power of the generating station may be concentrated on any particular section, if necessary, and stops for taking on water and coal are abolished.

As to the speed requirements, the electric locomotive and steam locomotive seem to be on about a par, recent preliminary tests on the Pennsylvania railroad lines from Camden to Atlantic City in New Jersey showing the maximum speed of the steam locomotive to be about 91 miles per hour, while the electric locomotive showed a speed of about 87 miles per hour.

The two systems which are in general use for high speed electric traction are the third-rail direct-current system, and the single-phase system, and considerable rivalry exists between the advocates of the two systems. The third-rail system requires a power house which generates high tension current, which is transmitted to the various sub-stations, which must transform and convert the high-tension alternating current into 550 to 650 volts direct current. It is claimed that this system is more expensive and requires more attention than the single-phase system which requires no feeders, fewer sub-stations, and overhead contact line and a simpler system. The direct current third rail advocates claim that the direct current motors used on their type of locomotives are more efficient, and that the car equipment type of generator and transmission line are less expensive.

Of the two systems, it seems at the present time that the single-phase system is the more desirable for moderate and long distances. The voltage on the line can be regulated to suit the length of road and condition of service, 3,300 volts being used for short roads and light service, while for long interurban roads with heavy service 11,000 volts are used. On long lines where transformers are required, the transformer station consists of one or more transformers with switching and lightning protection apparatus on both the high and low-tension side. The absence of rotating machinery and direct-

current switchboard gives a sub-station of unusual simplicity and one not requiring constant attendance.

The power house for a single-phase road contains alternating-current generators, direct-current exciters, switchboard, raising transformers and lightning protection, and switching apparatus. A frequency of 25 cycles is the favorite at the present time, although 15 cycles has been seriously thought of in the design of some of the projected systems. Steam turbines are giving good service under the conditions of varying load required, and gas engines have also been found to give excellent service in this class of work even when operating alternators in parallel.

Engineers for years have always wondered why the railroads did not take up the use of electric traction more seriously, but considering the enormous investment required to change the form of a railway system, the hesitancy to take up a new system was natural. But now that the power house and its radiating wires have made good in driving heavy trains for long distances at high speeds, it may be expected that the central power station will be a familiar sight on all lines of railroads, and that the stationary engineer will be an increasing factor in the transportation affairs in this country.

———o———

High Pressure Pumping Plants.

The difference of opinion among designing and operating engineers as to the best type of apparatus for a power plant is often strangely divergent. Not only is the very location of the plant itself a matter often of individual judgment, but from the type of boiler and prime-mover down to the least detail of the plant, a most radical difference in design is often noticed in plants in the same locality used for the same purpose.

One of the coming types of power plants which will eventually be used in all large cities is the high-pressure pumping station used for fighting fires, and while only one of these plants is thus far built and the other is building, the design of each is as different as the type of apparatus which can be used for high-pressure pumping will allow. For instance, in the plant at Philadelphia, which has been built several years, gas engines are used for the prime movers, while double-acting triplex pumps are used for forcing the water through the mains. In New York, where they are building high-pressure stations in several localities, electric motors will be used for motive power, while six-stage centrifugal pumps will be used to draw the water from the river and pump it at a pressure of 300 pounds through the high-pressure mains located on Manhattan Island.

No greater difference of design between two plants which are used for the same purpose could possibly be noted. When the plant in Philadelphia was designed, reliability of operation was the principal factor in the selection of apparatus, and gas engines were selected because they could be started quickly, the supply of fuel was always at hand, and, with four different sources of electric ignition it was thought there could be no failure from any source. Pumps of the piston pattern were selected because it was thought that for high-pressure this type possessed decided advantages over the centrifugal type. The results from these gas engine units have justified the designer's view. During the five years that the plant has been in operation there has not been a time when an engine has taken longer than 40 seconds to arrive at full operation from a state of rest; there has been practically no repairs necessary and the plant has repeatedly shown an efficiency of about 83 per cent.

After a careful investigation of these facts, the New York engineers decided to use induction motors, driving six-stage centrifugal pumps, owing to the lower first cost and lower cost of operation. The motors must necessarily depend on the street mains for their current, and the centrifugal pumps must of necessity at times be put under severe strain, owing to the character of the fire service.

These latter plants have not yet been put in operation, but they represent such a radical difference in design from a plant whose reliability of operation has been assured that the results will be awaited with much interest by other cities who contemplate putting in a high-pressure fire-fighting system. Reliability of operation is, of course, the chief factor for a plant of this kind, and it must not fail when there is a large fire, whose ravaging flames are eating up thousands of dollars' worth of property in a few minutes. Just what type of plant seems best for this service, however, must be demonstrated. This will now be possible, since designing engineers have had such widely different views as to the best type of pumping machinery to be used for reliable high-pressure service.

———o———

Education and Clear Thinking.

When the question arises as to what should be the education of an engineer, too much thought is generally given to the fact that educational training is not in itself always available for the purposes for which it is intended. A man may be very well educated in a certain line of engineering and yet not be fitted to perform the duties and responsibilities which are required of him in that line, and there are also many men who have successfully filled many difficult positions who have not had any technical education at all. Consequently, such men say that education is no value and that experience is the best teacher.

The man, however, who generally succeeds in any line of business, especially in those pursuits that involve technical and engineering training, is the man who can think clearly and whose mind does not fly off in tangents when he is considering a certain problem before him. Therefore, every individual act that causes a man to be able to analyze a problem or dissect a difficult condition that confronts him is a step toward education in the truest sense of the word.

The trouble, probably, with all of us is that we cannot discriminate as to what real education is. That is, we cannot figure, for instance, what good the working out of a concrete algebraic formula will ever do us. But if, by working out this problem, it helps to develop the mind in clear lines of thought, our education is just that much advanced. There are, however, men who can get just as much mind-training by doing and thinking out practical problems which come up in every-day work, and this, to a man that thinks, is just as much education as any mathematical problem ever invented.

It is not the method by means of which a man gets his education that is so important, so long as he gets it, and opinions will always differ as to what is the correct method of obtaining the most complete knowledge which will be the most helpful toward a certain end.

To be able to think clearly and to meet the issue squarely, is one of the most desirable things that a man can do, and in no matter what vocation he is employed, if he is educated along those lines he is bound to succeed.

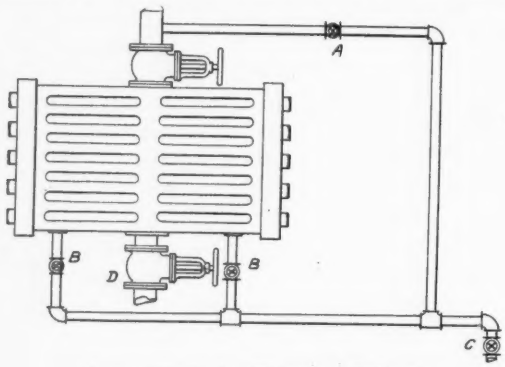
LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Methods for Keeping Idle Steam Cylinders Warm.

EDITOR THE PRACTICAL ENGINEER:

My plan for keeping an engine cylinder warmed up in case it is standing idle part of the time, especially in cold weather, is shown in the accompanying sketch. Tap a pipe into the main steam pipe above the throttle valve, the same size as the



Arrangement for Warming Cylinder

bleeder drain pipe, and connect it as shown. When the engine is standing idle open valves B and B and slightly open valve C; open valve A and close exhaust valve D. The steam will find its way all through the cylinder and steam chest, and the condensation will pass through valve C.

Benson, Minn. F. J. D.

More Books Written by the Practical Man Needed.

EDITOR THE PRACTICAL ENGINEER:

I have just finished reading Mr. Kavanagh's No. 3 "Talk With a Chief Engineer," and there is one part of that talk which strongly appeals to me; that is, where the chief speaks of engineering literature. I have not a word to say against algebra, as a good mathematical education is necessary to the successful engineer these days, but I am with the chief when he says that some of our books are useless to the working engineer. What makes the whole matter worse is that these same books are sold as practical books on stationary engineering, when in all truth they are theory, and theory only, from cover to cover. Theory in its proper place is all right, but that place is not, to my mind, the engine room. Theory would not run the plant twenty-four hours, and the engineer that has only theory is just a little better off than the engineer that has only a practical education. There are hundreds of engineers here in Massachusetts, where we have a license law and examinations, that cause men to lose five years' growth each time they are examined, that run their own plant twenty years without an accident, but who could not make good in a 100 horsepower plant that was new to them. This is because they never read a paper, magazine or book on the subject of engineering. Still, on the other hand, the man that only reads and takes little or no interest in the practical work is just as far off from being a successful engineer as the other chap.

Books, written not by the college man, but rather by practical educated engineers, are what we want, and the sooner we get this style of literature the better for the profession.

Speaking about the license law brings to my mind the fact that I have heard and read of a good many "kicks" against it. Now, the truth is that license law examinations are based on the fact that an engineer should have both a practical and theoretical knowledge of matters pertaining to stationary engineering. Now I know that lots of the kickers will say that I do not know what I am talking about. I do know, however, that although I have met a good many engineers, yet I can truthfully say that I never met one who, after he had received his license, did not consider the license law the best thing that ever happened. Here are a few questions that were asked me at an examination held on October 3d. As anyone can see, they are both practical and theoretical, although I will say that I did not get the license I was after, as I did not have enough practical experience:

1. Why has a slide valve lap?
2. If lap is added, what part of the valve gear must be changed?
3. If the piston struck both heads, what would you do?
4. Is oil good for boilers? Why not?
5. What is the angle of advance?
6. If you could not stop new piston packing from leaking, what would you do?
7. If the suction valves leaked in a duplex pump, would the cylinder drips look after the leakage?
8. How would you give more lead to a slide valve engine?
9. What is the effect of small port openings?

Leominster, Mass. A. D. P.

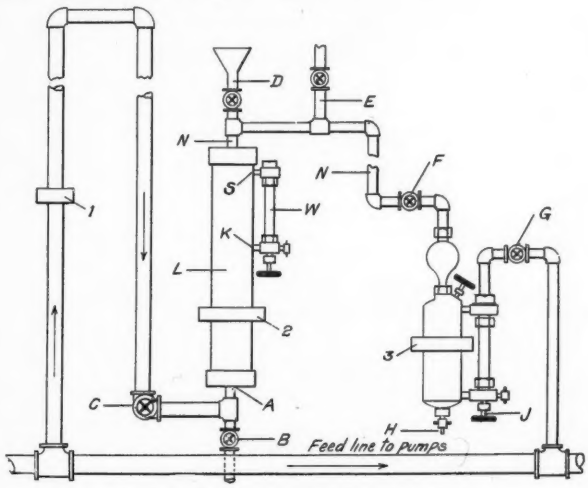
Arrangement for Keeping Lubricators Supplied with Oil.

EDITOR THE PRACTICAL ENGINEER:

In the plant where I am employed we were very much troubled by the boiler-feed pumps running dry of oil, as a small sight-feed oiler was used and the fireman sometimes forgot to fill it. The chief decided to rig up something which would be more satisfactory, so he made the contrivance shown in sketch, which has proved very satisfactory, a description of which may be of interest.

A piece of piping 3 inches in diameter and 3½ feet in length, which held about a gallon and a half of oil, was capped at both ends with caps tapped out for ½-inch piping. A 1½-inch pipe was then run up from the pump-feed line about seven feet above the top of this tank, and then brought down and entered in the bottom of the tank at A, as shown in the illustration. B is a drip valve and C is an angle valve placed at the lowest point, so that when steam is shut off while tank is being refilled with oil, a head of condensed steam or water will be maintained to begin work with after tank is filled. A half-inch pipe, N, was run up from the top of the tank, and to this pipe was connected pipe D, with the necessary valve and funnel with which to fill the tank. Pipe E is used as a vent for the

tank while filling, and is, of course, equipped with a valve. Pipe N was then brought down a couple of feet and connected to the sight-feed oiler, which had previously been used, in the ordinary way. The valves F and G are to shut off the oil in case a new glass is required in the sight-feed. H is a drip in the oiler and J is the regulating valve.



Arrangement for Filling Lubricator

At the time the chief was making this arrangement, we had on hand a couple of old gauge glass connections, so he tapped the tank L at K and S to receive them. When the tank needs refilling, water will be shown in the lower portion of the glass W. This arrangement was built next to a wall and fastened to it by means of the clamps 1, 2, 3. C. J. W.

Groton, Mass.

T. S.'s Condenser Arrangement Just as Economical.

EDITOR THE PRACTICAL ENGINEER:

In reference to T. S.'s condenser problem I wish to say that in starting a condenser pump, no steam is used on the suction end except to expel the air—and therefore there would be no more steam required, even if there was a twenty-foot lift; in fact, a pump does not really lift the water, because, after a vacuum is once formed, the atmospheric pressure forces the water into the vacuum.

The only difference, therefore, in the action of the pump while taking water from the pit will be a knocking in the suction pipe on account of so many turns in the suction pipe. I should, therefore, advise him, when making the change, to put an air chamber on the suction pipe near the pump. That was some pretty tall figuring that A. C. B. did in answer to this question, proving that it will take more power, and I do not wonder that Mr. Golden West gets after some of these ⅝-engineers. D. D.

Sydney, Nova Scotia.

When the Blow-Off Pipe Fails.

EDITOR THE PRACTICAL ENGINEER:

About 12.45 one winter's morning the blow-off on one of my boilers gave out, which caused the boiler to lose water rapidly. In spite of all I could do, I found the water was getting so low that it uncovered some of the heating surface. I at once covered the fire with wet ashes, which stopped the fire from making any more steam. I left everything else as it was and waited for the pressure to subside after disconnecting that boiler from the main.

I then started two inspirators and kept feeding the boiler until the pressure was zero. When the boiler was sufficiently cold, I took out the old blow-off pipe, which I found had seen better days, and substituted another pipe of the same size for it. I would advise every engineer to do what I did if placed in the same box as I was. A. J. C.

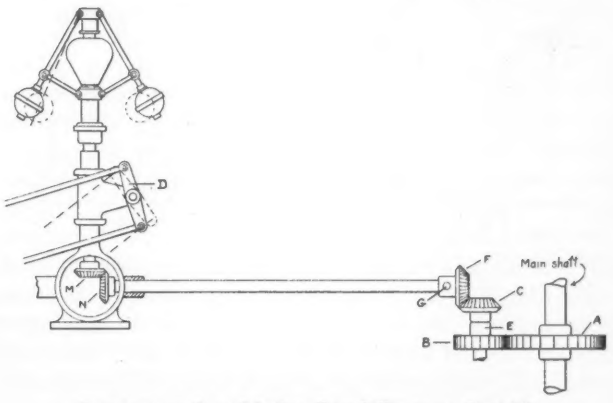
Fall River, Mass.

Remedy for Corliss Engine Governor Troubles.

EDITOR THE PRACTICAL ENGINEER:

It frequently happens that the small troubles around the engine room prove to be the most annoying. This is especially true of the Corliss engine, which, when in good running order, is ones of the simplest engines to operate, but when it gets "cranky" and develops some minor trouble, it often taxes the ingenuity, as well as patience, of an experienced engineer in locating and remedying the trouble. This was forcibly impressed upon the mind of the writer by a couple of recent experiences he had with the governors of Corliss engines, a description of which follows:

The first experience was with a direct-driven governor on an old style Lane & Bodley engine. This engine had about completed its nineteenth year of service, and was still in good running order, with the exception that some of the working parts of the governor had commenced to get shaky. This governor, as shown in the illustration, was direct-driven by means of gears, and these gears had become very much worn, causing considerable back-lash. This caused the governor to "dance," the governor balls and quadrant D assuming the different positions shown in the illustration. This, of course, changed the reach-rods and caused them to pull the cams up



Eliminating Lost Motion Cured Governor Trouble

or down, as the case might be, and sometimes the cams failed to catch and the engine would stumble and give a hard jerk. As the spur gearing A-B was badly worn, we rebabbited the bearing E and set the spur gear B further over towards A, to take up the lost motion. This, of course, threw out gear C, so gear F was brought over until it engaged in gear C, and was fastened on the shaft by having the tapered hole G reamed out and a large cross-pin put in. In this manner practically all the lost motion was eliminated, as the wear in the gears M-N was taken up by the downward weight of the governor, and

after starting up, the engine ran just as well as the day it was first installed.

Another case of governor trouble which the writer experienced was that of a belt-driven governor on a Corliss engine. There was considerable play in the gear box of the governor, as well as in the valve gear. To overcome this, the owner of the engine had built up the governor pulley with scraps of old rubber belting, and the governor belt was made of many pieces containing large knots. When the uneven places in the pulley and the knots in the belt ran over one another, it caused the governor to jump and the crab claw to loose its catch. I persuaded the engineer to put on a new governor belt and remove the pieces of rubber belt from the pulley, after which no further trouble was experienced with the governor.

Thus it may be seen how a mere trifle will cause trouble with Corliss engine governors, especially when they are old and their parts become worn, and I trust that the description of these two experiences may be of assistance to some engineer having trouble with his governor jumping.

Lynchburg, Pa. C. R. McG.

Blow-Off Tanks.

EDITOR THE PRACTICAL ENGINEER:

If the blow-off tank shown in the October issue, on page 17, has any advantage over the one in general use, as shown in Fig. 1, and which the Hartford Insurance Company recommends, I fail to see its good points. Even if the tank is very large, there will be practically full boiler pressure on the tank the moment the blow-off valve is opened, as the ¾-inch pipe is insufficient to relieve the pressure. The result will be a flow from boiler to tank too sluggish to serve its purpose. As to having even a ¾-inch pipe blowing steam at full boiler pressure into the sewer, it may or may not be injurious. Also, the manner in which the discharge pipe is connected to the bottom of the tank does not seem practical to me, as this pipe will fill up with mud and scale in a very short time, and I would suggest running same as shown in Fig. 2, which will at least afford a way of cleaning it out which the present arrangement does not permit. R. C.

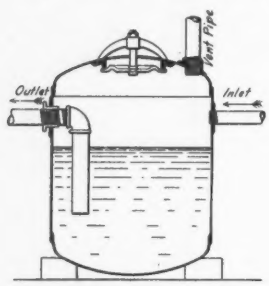


Fig. 1

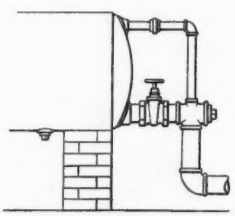


Fig. 2

Chicago, Ill.

Exhaust Connections of Pump.

EDITOR THE PRACTICAL ENGINEER:

In your November issue, Mr. L. C. shows an illustration of an exhaust connection of a duplex pump, with an inquiry as to the advantage, if any, of such a method of connection. I would suggest that this is an instance where art and engineering conflict, because from an artistic standpoint the job looks symmetrical, but from an engineering point of view it is certainly not above criticism.

With the arrangement as shown, the left-hand pump would kick its condensed water into the side of the other pump, and vice versa—a game of battledore and shuttlecock with the condensed water. A large sweep tee instead of the regular one would be a considerable improvement, and if the two pumps were not duplex but independent, there would be considerable interference if the two exhausts came together.

The pump shown by L. C. may have a passage between the two chests—an opening common to both—in which case a single pipe would do. Recently I put up a duplex kiln pump which had this common passage, and I plugged one side and piped the other. J. O. F.

New Orleans, La.

An Engineer Should Be On the Job.

EDITOR THE PRACTICAL ENGINEER:

The letter in reference to "Feed Water Regulators," in the November issue, interested me very much. There is a lot of truth in the statement that an engineer should be on the job both in name and in fact. I was once employed in the machine shop at a large electrical manufacturing plant. The engineer had to look after three 100 horse-power Brown engines, three 100 horse-power boilers, four large dynamos, keep the engine room clean, do his own firing, and besides this he had to go all over the different buildings and attend to any valves that required packing and other jobs of like character. He was often away from his engine room twenty minutes at a time. During the two years that I was there the wonder of it all was that no serious accident ever occurred, only a couple of armatures being burnt out.

At another time I was employed in a town plant, and I often had to turn the engine room over to some employee who was absolutely ignorant of engineering, and go away for several hours. The safety of that plant must have been due to some powerful fairy, because why there never was an accident was a mystery. In small plants the engineer often has plenty of time to do other jobs, but he should be near his engine room at all times while he is on duty. H. B.

Toronto, Can.

Method for Working Out Pump Problem.

EDITOR THE PRACTICAL ENGINEER:

The following question was put to me a few days ago, and as the work involved may be of interest to your readers, I submit the same, with answer and method of operation:

A pump, in doing a certain amount of work, is known to consume 5 horse-power, the data being as follows: Diameter of plunger, 1½ inches; stroke, 6 inches; number of strokes per minute, 15. The water is discharged into a reservoir and the work of pumping the water through the line of pipe requires 5 horse-power. Required the pressure per square inch, against which the plunger is pumping, all losses to be neglected.

The quantity of water which the pump is delivering must first be found. As the diameter of the plunger is 1½ inches, the area is 1.7671 square inches, and as the stroke is 6 inches and there are 15 strokes per minute, $1.7671 \times 6 \times 15 = 159.039$ cubic inches of water pumped per minute. If it were not known just what horse-power the pump was consuming, it

could be found from the following formula:

(Lbs. of water pumped per min. × Head in feet) ÷ 33,000. But as the horse-power is known in this instance, (33,000 × 5) ÷ Lbs. of water pumped per minute = Head in feet.

Since one pound of water contains 27.7 cubic inches, 159.039 ÷ 27.7 = 5.741 pounds of water discharged per minute, so that supplying this value in the formula, we have

$$(33{,}000 \times 5) \div 5.741 = 28{,}740 \text{ feet head}$$

which is the distance or equivalent through which the water is pumped to consume 5 horse-power. But we desire to know the equivalent pressure per square inch acting against the pump plunger, so that all that is necessary is to multiply 28,740 × .434 = 12,473.16 pounds per square inch pressure, because every foot head equals a pressure of .434 pounds per square inch.

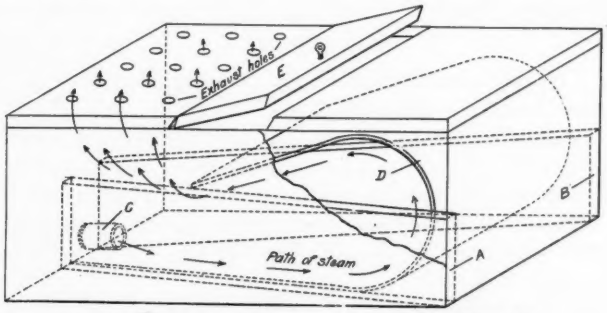
Scranton, Pa. CHAS. J. MASON.

A Home-Made Washer for Washing Overalls.

EDITOR THE PRACTICAL ENGINEER:

The following is the description of a home-made washer for washing overalls, etc., and is used with great success in the plant where I am employed:

The box, as shown in illustration, is made of rough lumber, 18 in. wide, 18 in. deep by 3 ft. long. Inside the box, and fastened to the bottom, are two strips of wood, A and B, 1 in. by 12 in., and long enough to run lengthwise across the bottom from the centre of one side to the corners of the opposite side. Between these strips of wood, as they come together towards the centre of one side, is placed a pipe C, close to the bottom of the box. This pipe is for admitting steam and projects into the box for about two inches. A piece of galvanized iron D is cut tapered, so as to fit between the strips A and B, and one end is bent over at the top, as shown in illustration. In the cover of the box, at the end where the steam enters, several holes are bored to let the steam escape. Part of the box cover E is loose, and is beveled on the edges so that it will fit tight and yet permit of its being removed quickly without scalding



Home-Made Arrangement for Washing Overalls

the operator. The steam is taken from the steam separators and a valve is placed in the pipe connecting the washer and separators, at a distance from the washer, to prevent anyone being burned when turning on steam.

The operation of the washer is as follows: The overalls, or other clothes, are first sprinkled with soda ash or any ordinary washing powder, and then placed in the box and cover closed. When the valve admitting the steam is first opened, boiling water at boiler pressure is driven into the washer and thoroughly wets the clothes. When the steam comes in they are blown by it around the inside surface of the iron deflector D, and drop in the narrow space between the guides A-B and in front of the steam jet C. The steam then blows them around the deflector again, and this operation continues, the clothes making 20 or 30 trips a minute around the deflector. The wet steam and dirty water flow out through the exhaust holes in the top and comes out thick with dirt and grease.

In five or ten minutes the dirt and grease will be removed, and when cover is taken off (after first shutting off steam), the steam blows out. Either a pail of water is thrown in to cool off the clothes, or they are hooked out and dropped in warm water, and rinsed by plunging them up and down. In this manner, two or three suits of overalls can be washed, rinsed and hung up to dry in fifteen minutes.

It is necessary, of course, to use wet steam, as dry steam will burn the dirt and grease into the clothes. In opening the washer, care should be taken, as a cloud of this wet steam may roll out which may be hot enough to burn the skin from the face and hands. The valve should be opened slowly, to allow the hot water to soak well into the clothes and make them heavy enough to pound against each other while traveling around inside the box. The soda ash, or washing powder, should be put in each pocket, and inside the legs and sleeves and the clothing then rolled up and placed in washer. In this way the washing powder lasts longer and is dissolved while passing through the dirtiest parts.

This washer can easily be made by any engineer, as its construction requires but a small amount of time and material, and should any of the readers wish to make one, I can guarantee satisfactory results and a great saving in laundry bills.

C. M. G.

Water for Producer Gas Plants.

A factor in producer gas installations is the cost of the water used in scrubbing the gas and for cooling purposes. In the Somerville power station of the Boston Elevated Railway Company, the average amount of water required has been 281 pounds per kilowatt hour. The equipment at this plant consists of one pair of Loomis-Pettibone gas producers, two 600 horse-power gas engines of the two-cylinder, four-cycle type, and two 350-kilowatt generators. When the water was bought for this plant it cost about twice as much as the coal. Consequently, recourse was had to a dirty stream from which they pumped by two-staged, electric driven centrifugal pumps which force the water through a pressure sand filter. The discharge of water from the gas scrubbers is very dirty, being full of lamp-black, and in this particular case is too thick to put back into the stream. A sand filter basin, 246 square feet in area, tile underdrained, is used for removing the lamp-black, so that the water is returned cleaner than it was taken from the stream.

Engineer's Licenses for Saginaw, Mich.

Licenses for stationary engineers of Saginaw, Mich., are now required under an ordinance recently enacted by Common Council of that city. As a preliminary to securing a license, candidates must undergo an examination, the examining board being composed of Alex. Strachan and William Dever. After passing the examination the cost of securing the necessary license is $2, which is paid to the city treasurer.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Peculiar Blisters.

EDITOR THE PRACTICAL ENGINEER:

While cleaning some of our boilers recently we found on some of the flues, blisters about three inches in diameter, the depressions being outward. I also saw a large blister on the fire sheet of a boiler which was almost new, the blister being about 6 or 8 inches diameter. It was the same shape as a bag, but the depression was inward. The blisters in both these cases were forced in against the pressure. I would like to hear the opinion of other engineers about this.

J. W. DAVIS.

Remedy for Stuffing Box Trouble Wanted.

EDITOR THE PRACTICAL ENGINEER:

I wish to ask your readers' opinion on the following: We have a duplex pump for elevator service working under 100 pounds pressure. The stuffing box on one side of the water end has given considerable trouble for no apparent reason. The construction is of the ordinary kind shown in Fig. 2, and square flax has been used for packing the same. When packing this box we have to leave it so loose as to allow considerable leakage; if not, the gland would invariably break in two. As it is quite a job to replace one of these glands, we finally had one made of brass in two halves, as shown in Fig. 1. This

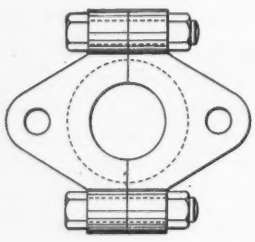


Fig. 1

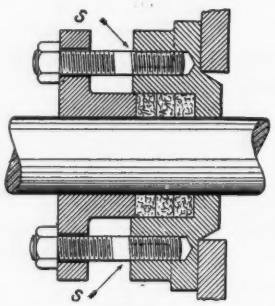


Fig. 2

will stand the strain all right, but if some one who is not "wise" to this box undertakes to pack it, one or both of the studs S S are sure to break off.

When the rod travels towards the water end, the gland is forced out in the opposite direction, which shows that the rod somehow creates an enormous pressure in the box at a time when there should be no pressure at all, as this is the suction stroke on that end. The rod is worn a trifle, but no more than its mate on the other side, and that box has never given any trouble. Besides, the trouble with this box has existed ever since the pump was new. Possibly some reader of THE PRACTICAL ENGINEER has had some similar experience. Any suggestion as to a remedy will be very much appreciated.

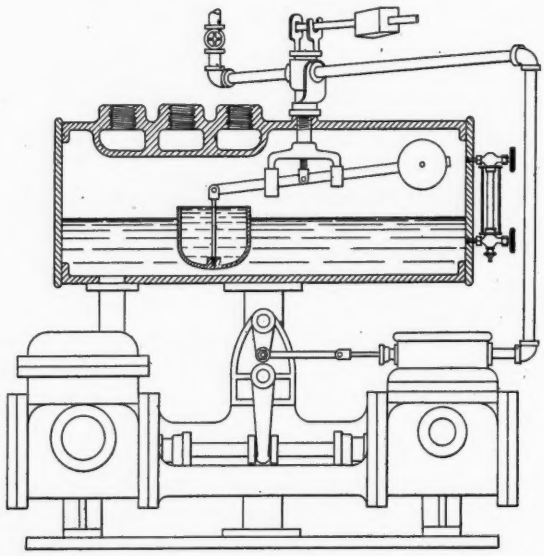
Chicago, Ill. R. C.

What Causes the Pump to Race?

EDITOR THE PRACTICAL ENGINEER:

Here is something about which I would like to hear from the experienced engineers:

In our plant we have a Deane duplex pump, governed by a float in a receiver, as shown in sketch. This pump keeps the



heating system clear of water and acts as a return trap. Now, when the steam is shut off the heating system, the pump will speed up and will continue to race until shut down. No water is returned to the boiler at that time, as the tank is empty. Can anyone explain why this is? A. D. P.

Leominster, Mass.

Horse Power Required for Heating Factory.

EDITOR THE PRACTICAL ENGINEER:

I would like you to tell me how many pounds of steam at 60 pounds pressure will be required to heat 123,000 cubic feet of factory space with radiator pipes to a temperature of 72 degrees; or what horse power boiler would I require to do this work, starting steam in pipes at 5 to 5.30 to get factory warm at 7 A. M.

The facts are these: We have a large factory that I have been heating, and doing other work, such as heating glue. We have been doing this with a 60 horse-power boiler and have had to use forced draft to keep steam up. I use both hot air and direct heating. The company have added an addition on the north side and have taken down partitions on the same side to make 123,000 square feet more than I had last winter. The question now comes up, how much coal will it take to heat this extra space? I would say that the addition is exposed on three sides to the weather, and there are 12 large windows on each floor, there being four floors, each 11 feet high. It does not seem to trouble the

owner, as he has not made any move to heat this extra space, because he thinks that because I can do what I have done, I can do more. I also would like to say that I get power from outside to run my fan, so I only use my boiler to heat with. L. J. P.

If the size of walls and windows were exactly stated, the number of heat units required to heat the additional space could be obtained from the formula:

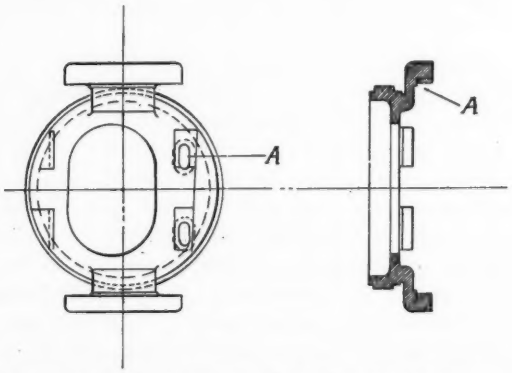
$$H = \left(\frac{n}{55} C + G + \tfrac{1}{4} W\right) t$$

in which H = total number of heat units required per hour per degree of difference between the room and the surrounding space, n = number of times the air in the room is changed per hour, G = square feet of glass or window surface, W = square feet of wall surface, and t = difference in temperature between the room and outside. Having calculated the value of H, the number of square feet of heating surface required can be obtained by dividing it by 280, which is the number of heat units which one square foot of heating surface gives out under ordinary conditions. For general purposes, however, a rule which is often used is to allow one square foot of boiler surface to every 400 cubic feet of factory space where there is considerable exposure. In this case it will require 123,000 ÷ 400 = 308 square feet of boiler heating surface. Allowing 12 square feet per horse power, it would require a boiler of 26 horse-power additional to do the extra heating, or about 780 pounds of steam per hour.

Remedy for Trouble With Russell Engine.

EDITOR THE PRACTICAL ENGINEER:

Will some reader of the Practical Engineer explain the working of the "Goddard Valve" to me. The engine was built by Russell Engine Company, of Massillon, Ohio, about twenty years ago. It has a fly-wheel governor which is rather complicated, and I don't fully understand its working details. When the engine is running light and up



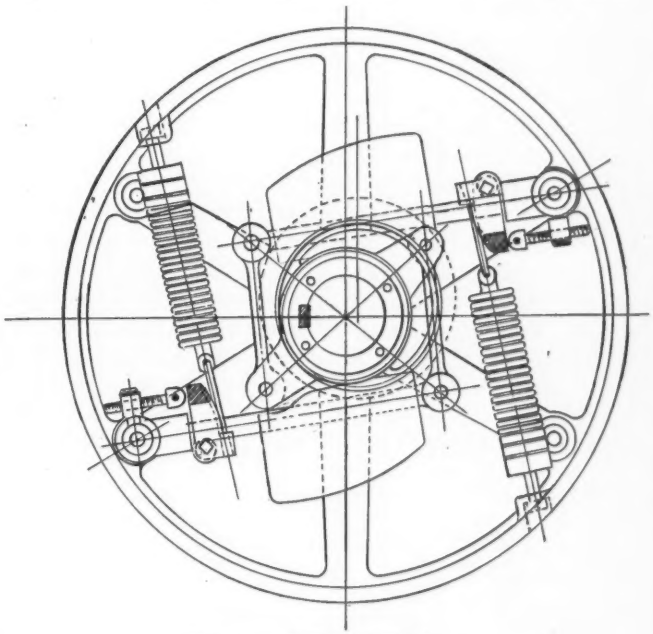
Location of Gib and Key in Russell Engine Governor

to its full speed, things run quiet, but when loaded heavy so that cut-off takes place later, there is a pounding somewhere in the governor just the same as when it would be working under low steam pressure.

New Westminster, B. C. G. A. B.

The Russell Engine Company, of Massillon, Ohio, to whom this question was referred, give the following explanation:

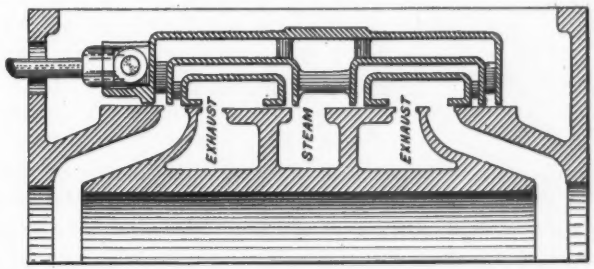
"We note carefully the complaint G. A. B. makes and the time when engine runs quiet, and also when it makes a pound. The cause for this noise is due to the fact that the engine has been operating evidently for several years at



Governor of Russell Engine

about the same load and the inner eccentric wedge and hub plate gib have worn shoulders, and now when the load is thrown on of larger proportions, the travel is more and slides upon these shoulders, consequently there is a pound. The remedy is to take the gib and key out and scrape the shoulders down and put them back into place. As soon as the shoulders are removed the knock will not take place, as the governor will be free.

"We enclose herewith a cut showing the governor, and we have marked the points at A A where the gib and key are located, and we would suggest that the party remove these and scrape the shoulders down.



Section of Valve used on Russell Engine

"Regarding an explanation of the valve mechanism, we enclose a cut showing the type of valve in the engine which takes steam internally and is balanced by admitting steam on the back of the valve through a needle hole port in the steam port of the valve, and there is a corresponding needle hole part in the exhaust port of the valve so as not to get too great an accumulation of pressure behind the valve."

Expansibility of Steam.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly give me an answer to the following question which was asked at a recent examination: "Give full particulars of the expansibility of steam."

Edmunton, Canada. C. E. P.

The expansibility of steam depends upon a number of conditions; pressure, volume and temperature. When a cubic inch of water is converted into steam at the ordinary pressure of the atmosphere, its volume is increased 1645 times. If, however, steam is produced at any greater pressure, its volume will be very nearly inversely proportional to the pressure; that is, at two atmospheres, one cubic inch of water would occupy about 855 cubic inches when converted into steam and at four atmospheres it would occupy about 457 cubic inches, and so on. From this it can be seen that the greater the pressure of the steam, the less amount of space will a given weight occupy, and the greater will be its density. The amount of expansibility of steam under a given condition is proportional to the initial pressure and temperature, and to the final pressure and temperature to which it is allowed to expand. Saturated steam, for a given pressure, can never be raised higher than the temperature of the water from which it was generated so long as it remains in contact with the parent body of water, but should the temperature of the steam be altered without altering the pressure, it becomes what is known as superheated steam. Superheated steam approximates a perfect gas and follows what is known as Boyle's or Mariotte's Law, its volume always varying inversely as the pressure. By this law steam which occupied one cubic foot at 20 pounds absolute pressure would occupy four cubic feet at 5 pounds, and half a cubic foot at 40 pounds absolute pressure. But steam as commonly used in the steam engine is not superheated, but used under the conditions as found in any table of saturated steam. It differs somewhat from a perfect gas. The volume, instead of increasing inversely as the pressure, increases less rapidly; the difference, though not very great, is so large that it must be taken into acount in all calculations as to the efficiency and behavior of steam in a steam engine.

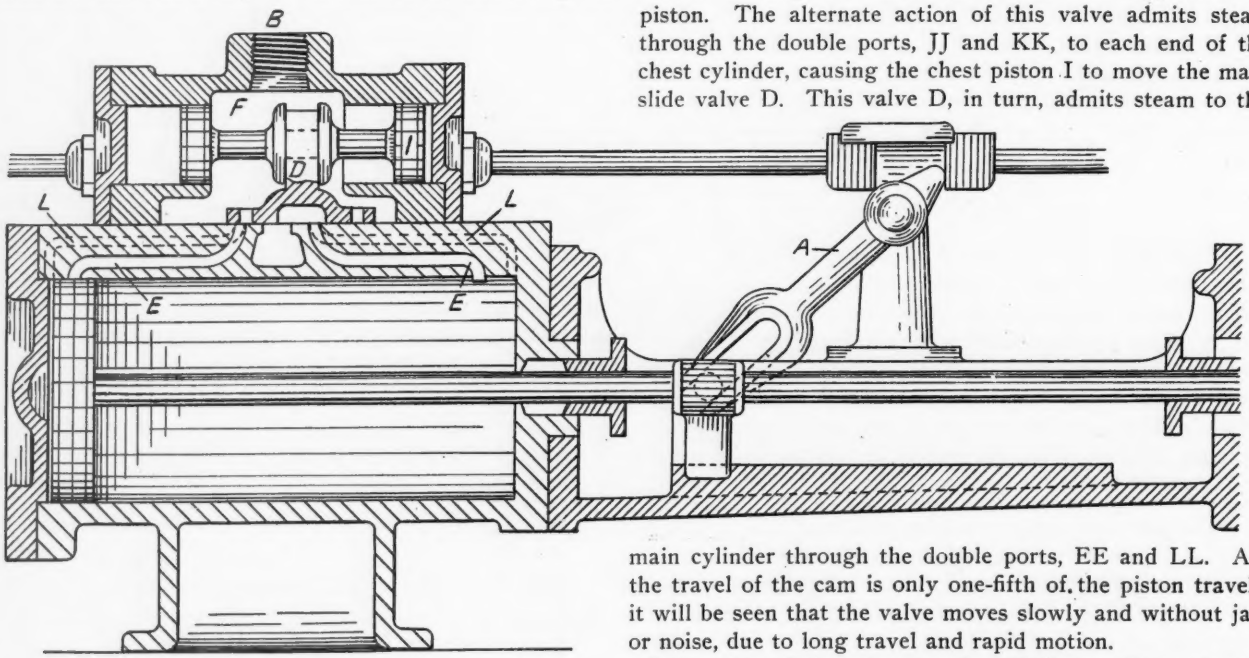


Fig. 1

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Burnham Pump Valves.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly explain to me the action of a Burnham pump, and how do you go about setting the valve?

Pittsburgh, Pa. C. H. M.

The valve gear of the Burnham pump is shown in the accompanying illustrations: a longitudinal section of the pump is shown in Fig. 1, and the auxiliary valve and valve chest is shown in Fig. 2. Motion is imparted to the slotted arm and cam A by means of a crosshead and a roller on the piston rod. The cam on arm A comes in contact with blocks on the valve stem which can be adjusted so that the stroke may be shortened or lengthened. The valve stem on which is fastened the auxiliary valve H, as shown in Fig. 2, moves in a direction opposite the piston. The alternate action of this valve admits steam through the double ports, JJ and KK, to each end of the chest cylinder, causing the chest piston I to move the main slide valve D. This valve D, in turn, admits steam to the main cylinder through the double ports, EE and LL. As the travel of the cam is only one-fifth of the piston travel, it will be seen that the valve moves slowly and without jar or noise, due to long travel and rapid motion.

The action of the valve gear is as follows: Steam is admitted into the steam chest at B, into the space F, between the chest piston heads and into the auxiliary valve chest G, shown in Fig. 2. When the auxiliary valve H is in the position shown, steam passes into both ports J and K, but as the port J is closed by the chest piston I, no steam can enter the chest cylinder through it, but the other port K extends to the extreme end of the chest cylinder, and never being covered by the piston, is open and admits steam into the space M. As the port is small, the space is filled slowly and the piston moves gradually until it uncovers the large port J, when the full volume of the steam is admitted.

During this movement of the chest piston the left-hand port J is open to the exhaust until it is covered by the chest piston. When it is covered, it has no connection with

the exhaust and consequently there being no outlet for the exhaust vapor, it is compressed and forms a cushion for the chest piston I.

The chest piston in its movement carries with it the main valve D, admitting steam to the main cylinder through the double ports EE and LL, which are arranged the same as in the chest cylinder and same cushioning and slow starting

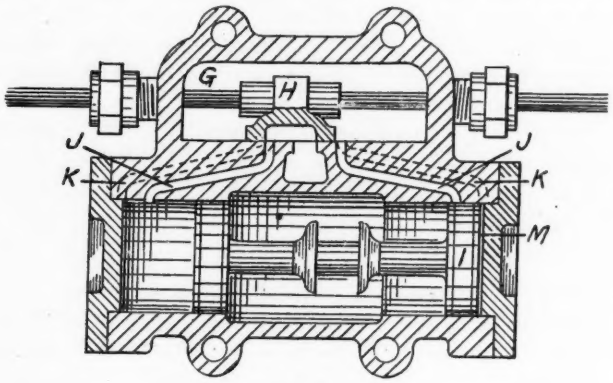


Fig. 2

of the piston occurs in the main cylinder as in the chest cylinder, each having double ports.

To set the valve, set the lever A plumb and make the valve cover all the ports equally. The pump should then be ready to start.

Pressure Required to Pump Water Through a Horizontal Pipe.

EDITOR THE PRACTICAL ENGINEER:

What pressure will I have to carry at the end of a 4-inch pipe, 2,000 feet long, to make it deliver 24,000 gallons per hour at the other end, the pipe being horizontal.

Lorain, O. Q. J. B.

To solve this problem use must be made of hydraulic tables, which depend upon experiment. For instance, it has been found by experiment that to pump 24,000 gallons of water per hour, or 400 gallons per minute, requires 109 feet head for every 1,000 feet of pipe, so that in the given case it requires 218 feet head to pump the required quantity of water, as the pipe is 2,000 feet long. As one foot head equals .434 pounds per square inch pressure, it will require $218 \times .434 = 94.6$ pounds per square inch to pump the water through the pipe.

Compressed Air.

EDITOR THE PRACTICAL ENGINEER:

Kindly send me a rule for finding out the number of cubic feet of free air which will fill a vessel of a given size under a pressure of, say, from 70 to 80 pounds. For illustration, we have a closed cylinder 4 feet long and 12 inches in diameter; how many cubic inches of free air will it take to fill this tank at 70 or 80 pounds pressure? C. H. C.

Cedar Rapids, Ia.

When air is compressed into a smaller volume, if the temperature remains constant, the pressure increases directly in proportion to the decrease in volume; that is, if the volume is one-half, the pressure will be doubled; if one-third, the pressure will be increased three times, and so on for any decrease of volume. There is, however, another important factor which must be considered, and that is the increase in temperature and consequent increase in volume due to the heat developed during compression.

Assuming, however, in this case that the temperature is constant, the air will be compressed from 14.7 pounds per square inch to 80 pounds gauge, or 94.7 pounds absolute, and the ratio of compression will be $94.7 \div 14.7 = 6.44$. Since a tank 12 inches in diameter and 4 feet long contains a volume of free air of 5,428.8 cubic inches, the number of cubic feet of air required to fill the tank under 80 pounds gauge pressure will be $5,428.8 \times 6.44 = 34,961.4$ cubic inches.

Steam Space in Boilers—Size of Pump Cylinders.

EDITOR THE PRACTICAL ENGINEER:

Will you please publish in your valuable book a formula for finding the steam space in a boiler? Also how do you calculate the size of the different parts of a pump; I mean the steam piston, the draft pipe and discharge pipe?

N. Grafton, Mass. W. W. T.

If the diameter of the boiler, the distance that the water line is from the top of the boiler and the length of the boiler are known, the cubical contents of the steam space of a tubular boiler can be found. If D = diameter of boiler, h = height of steam space, l = the length of boiler, and C = cubical contents of steam space, then

$$C = \left(\frac{4 h^2 \sqrt{D}}{3 \sqrt{h}} - .608 \right) \times l$$

In a tubular boiler the upper line of the top row of tubes is commonly two-thirds of the diameter of the boiler from the bottom; over this is from 2 to 4 inches of water, depending on the size of the boiler; all above this is steam room. In water-tube boilers, the water is carried up to about one-half the diameter of the combined water and steam drum.

When calculating the sizes of a steam piston, suction pipe and discharge pipe of a pump, we would recommend that a pump catalogue be referred to, as it depends upon the duty of the pump as to what should be correct sizes of the different parts of the pump. The diameter of the steam cylinder depends upon the character of the work which the water cylinder must perform, and the sizes of the draft and discharge pipes also depend upon the size of the water cylinder.

If, however, it is desirable to make calculations, the following formula will give the necessary results: If A = area of steam cylinder, a = area of pump cylinder, E = efficiency of pump, P = steam pressure per square inch, and p = resistance per square inch on pump cylinder, the

$$A = \frac{a\,p}{E\,P}$$

E is commonly taken at about 70 per cent. for ordinary direct acting pumps. The steam pressure, P, is the mean effective pressure in the cylinder; the water pressure p is the mean total pressure acting on the pump plunger or piston, including the suction. It must be understood, how-

ever, that the pressure on the pump piston is frequently much greater than that due to the height of the lift, on account of the friction of the water in the valves and passages, which increases rapidly as the velocity of the water increases.

The speed of water through pipes and pump passages is commonly 100 to 200 feet per minute. For a velocity of 200 feet per minute the diameter of the discharge pipe should be

$$\text{diameter} = .35 \times \sqrt{\text{gallons per minute}}$$

and the suction pipe should be one size larger.

Scavenging a Gas Engine Cylinder.

EDITOR THE PRACTICAL ENGINEER:

Will you kindly explain to me what is meant by scavenging a gas engine cylinder ? G. R. T.

Boston, Mass.

By the scavenging of a gas engine cylinder is meant the cleaning out of the exhaust gases from the cylinder before the next charge is admitted. In every gas engine, after the explosion and the gases are exhausted, there are some burned gases lingering in the clearance spaces. When these burned gases mingle with the incoming fresh charge there must necessarily be a reduction in the efficiency of the explosion. If these burned gases are expelled from the cylinder by a charge of fresh air before the admission of the explosive charge, the scavenging will allow the efficiency of the engine to be increased.

Edison-Lelande Cells.

EDITOR THE PRACTICAL ENGINEER:

Will you please tell me the reason why it is that, after renewing the electrolyte and plates of an Edison-Lelande cell, I cannot get a greater current than from five to seven amperes? When renewing, I followed directions closely.

Milwaukee, Wis. L. T.

The electro-motive force of a cell of this type is about one volt on starting and about .75 volt when running a short time. As the internal resistance is very low, the current which can be obtained will be about 15 to 20 amperes. It is therefore probable that the trouble lies in the internal resistance of the cell. This may be due either to using impure chemicals or in not placing them in the cell properly. The elements used in this cell are zinc and copper oxide, and the electroylte is usually caustic potash, and the internal resistance can be reduced and large currents obtained if a film of metallic copper is placed on the copper oxide before the battery is put into use.

Method Used for Drying.

EDITOR THE PRACTICAL ENGINEER:

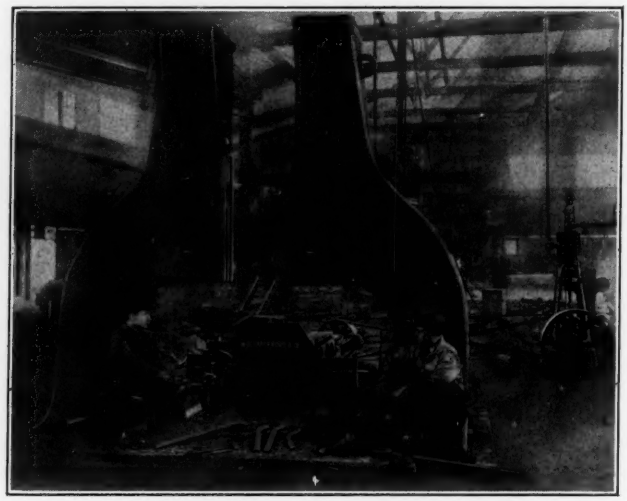
We are about to put in a drying room in connection with our factory, and I would like to know the general scheme which is generally used for drying purposes.

New Orleans, La. A. S. L.

The object to be attained in all drying rooms is to provide means of producing a rapid current of air, which, when directed through the articles to be dried, will carry off the surplus moisture which they contain. The rate of drying will depend partly upon the temperature of the air passing through the room, and partly upon its dryness. If the air is nearly saturated with moisture, drying takes place very slowly under ordinary conditions, even if a steady stream of air should pass the material to be dried, but as the capacity of air to absorb moisture varies with the temperature, it may have its drying properties increased by heating it. The general arrangement used, when natural means of drying are insufficient, is to install a cased fan, a steel pipe heater encased in a steel plate jacket, through which the air passes in the process of heating, and a system of ducts through which the air is delivered to its destination. The fan may be equipped with either a direct-connected engine or electric motor, or it may be belt-driven, as desired. It is usual to make the heater in sections so that it may be made adaptable for all conditions.

Interesting Machine Repairs.

An interesting repair to a 100-ton steam hammer, which was recently made by H. B. Underwood & Co., 1025 Hamilton St., Philadelphia, illustrates to what ingenuity it is often necessary to go in order to make repairs quickly and accurately at the place where the piece of machinery is located. The accurate repair to any piece of machinery, which must be made without its removal from the foundation, depends almost wholly upon the adaptability of the portable tools and



Underwood Portable Planing Machine at work on 100-Ton Steam Hammer Anvil Block

their experienced operation. The accompanying illustration represents one of the Underwood portable planing machines planing off the anvil block in the plant of the Tioga Steel & Iron Co., Philadelphia. The anvil block was so large that it was almost impossible to remove it from its foundation, so a small steam engine was erected close to the steam hammer, and a portable planing machine was erected and driven by the engine. The job was done as accurately and with very much less time and expense than if the anvil were taken from off the premises.

Other very interesting work done with the Underwood portable tools is the boring of cylinders in position, reseating valves of all kinds, replacing crank pins, turning crank shafts

of all sizes and all kinds of special work. The use of the portable milling machine was very interestingly shown at the plant of Worth Bros., Coatesville, Pa., where the interior guides in the housings for the enormous rolls required planing. No other tool was adaptable except a specially designed milling machine which was erected between the guides, and which completed the job in a very satisfactory manner.

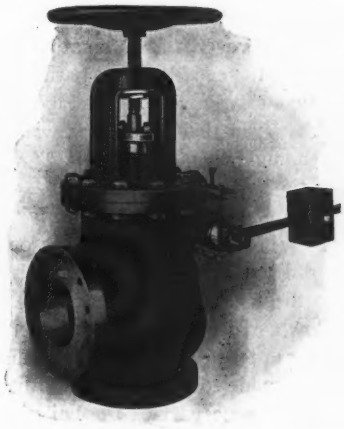
The men from the Underwood machine shops are sent all over the country to make emergency and other seemingly impossible repairs to all kinds of machinery, and as each repair is usually a special job, and requires special portable machinery, each one is exceedingly interesting. Practically all the special tools for this work have been designed and built in the Underwood shops.

The Uses of the Lagonda Cut-Off Valve.

In all power plants it is advisable, as far as possible, to make use of the necessary safety appliances which are available so that the chances of having an accident are reduced to a minimum. Many accidents which occur are unavoidable, so that steps should be taken to prevent any danger or damage caused by these accidents. For instance, considerable damage is often done by the occasional bursting of steam mains or the failure of boiler tubes which, if a proper valve were used on a boiler, could be prevented. Such a valve, which shuts off the boiler from the steam main, or which prevents the steam from flowing back into the boiler, should an accident happen either inside or outside of the boiler, is the Lagonda Automatic Cut-off Valve, shown in the accompanying illustration. As a cut-off valve, it acts automatically, but by turning the hand-wheel it may be used as an ordinary stop-valve. As steam is raised in the boiler, the valve opens it to the main when the boiler pressure is equal to the pressure in the line, thus preventing any accident from opening valves when there is considerable difference in pressure.

This valve works either way and does not depend upon differences in pressure for its action, but upon the actual flow of steam through the valve. If a tube in one of the boilers should give way, it shuts down that boiler only, and allows all the other boilers in the battery to go on supplying steam as usual. With an ordinary stop-valve the fireman is frequently scalded in trying to shut off the main, or is driven from the fire room without being able to do anything to save the entire plant from shutdown. This cut-off valve will, unless intentionally opened, stay closed until the pressure is raised again. It is, therefore, perfectly safe for a man to go inside to repair damages as soon as the injured boiler has cooled off sufficiently.

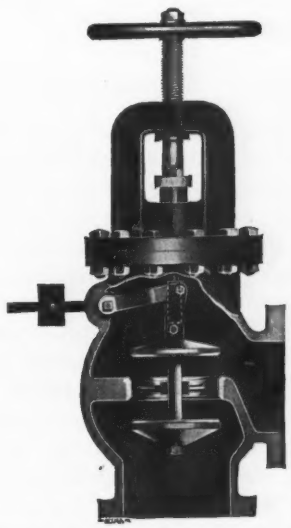
If, on the other hand, a steam header bursts, or a joint breaks, or a cylinder head blows off the engine, the cut-off valves on all the boilers close immediately before the room has been filled with steam, and repairs can proceed at once. The operation of this valve may be seen from the accompanying cross-sectional view. It is installed so that the lower valve disc is toward the boiler and the hand-wheel on top. Normally, when the boiler is not working, the upper valve rests upon the seat and prevents steam from the main from entering the boiler. When the steam pressure in the boiler is raised to slightly exceed that in the main, the valve lifts and steam flows from the boiler into the main. The valve is very nearly counter-balanced by a weight on an external arm. The leverage of this weight may be adjusted to different rates of steam flow and boiler output. The normal flow of steam into the main raises the discs to mid-position, as shown. The valve remains in that position as long as steam is being drawn from the boiler at the normal rate, but in case of a break on line side of the valve the



The Lagonda Automatic Cut-Off Valve

excessive rush of steam would carry the lower valve up against the seat, shutting off the boiler. When the flow reverses, the upper valve drops to its seat and shuts off the steam. The rate of flow at which the boiler would be shut off is determined by the weight and by the distance between the two valve faces. This is adjustable to correspond to the greatest overload at which it is desired to operate the boiler.

The following tests made on this valve in the power house of the Anaconda Mines, Anaconda, Mont., illustrate how it

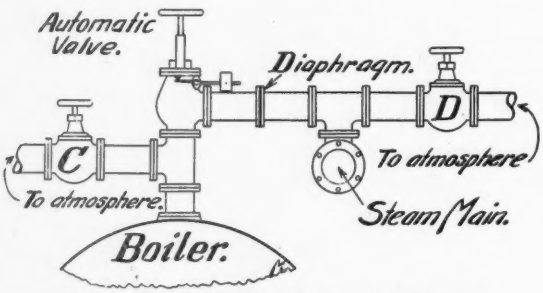


Section of the Lagonda Automatic Cut-Off Valve

acts in case of accident. The accompanying illustration shows the arrangement for the test. The automatic valve was placed between the boiler and the main. On the boiler side was a connecting opening valve "C," communicating with the atmosphere, and on the main side was another quick-opening valve "D," also opening to the atmosphere. The boiler was a 300

horse-power Stirling water-tube, carrying a pressure of 150 pounds. When this pressure was reached, the valve "D" was opened wide enough to allow steam to escape from the boiler to correspond with different rates of driving. To determine how the valve would act if the main should burst, the valve "D" was thrown suddenly wide open. The water rose so rapidly in the glass that, if it had been allowed to continue, it might have resulted in the destruction of the boiler. Before the water had gone up two inches, however, the automatic valve closed tight. A test was then made to see if the automatic valve would close if the break opened slowly. A steel diaphragm was placed in the pipe, as shown; in this diaphragm was an opening 1⅝ inches in diameter, and when the valve "D" was opened suddenly the automatic valve closed promptly. This diaphragm was then removed and another substituted with an orifice 1½ inches diameter. When the valve "D" was opened again, the automatic valve did not close, showing that its point of closing was between these rates of delivery. In this case it was set to close at a flow corresponding to 600 boiler horse-power.

After making these tests the boiler was again placed in service, and a test was made to see what would happen if a boiler tube should break or some part of the boiler give way. This was done by suddenly opening valve "C," upon which the automatic valve closed promptly, shutting off the main. Fifty-four tests like these were made and, it is said, the valve acted promptly each time.



Connections for Testing the Lagonda Valve

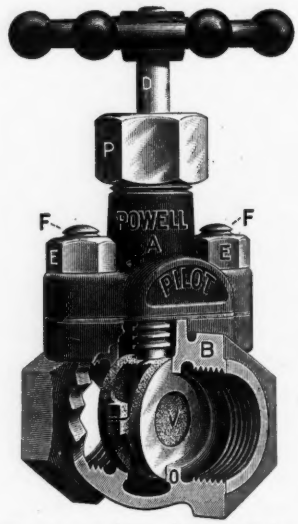
When used in refrigerating plants, the cut-off valve is placed in the line, and in case any of the ammonia pipes should burst or the cylinder head blow out, the valve will close, thus preventing the escape of ammonia with its serious consequences.

The Lagonda Automatic Cut-off Valve is made by the Lagonda Manufacturing Company, Springfield, Ohio.

The Powell "Pilot" Gate Valve

The accompanying illustration represents the latest type of iron-body gate valve, manufactured by the William Powell Co., Cincinnati, Ohio. The iron body is designed with heavy lugs on either side of the neck, carrying stud bolts F, and the bonnet cap A has corresponding lugs drilled to template, which ensure a perfect joint and constant alignment, and allows the bonnet to be replaced after it is taken apart for inspection and repairs. The joint is tightened by means of the hexagon nuts E, packing being placed between the faces of the bonnet and body, so as to insure a tight joint. The brass stem D and bonnet are cut with the latest type of Acme thread. The brass packing nut P is made of large size, so as to allow for ample packing around the stem.

The discs are double wedge, with ball and socket back, making them adjustable, and they are hung in recesses to the collar on the bottom of the stem. The discs work in a tapered seat and expand or collapse in opening and closing, which gives a tight joint, with only a comparatively small strain on the valve stem.



The Powell "Pilot" Gate Valve

The Powell "Pilot" gate valves are made either with iron body and brass fittings, or all iron, the all-iron gate valve being used for controlling ammonia, cyanide solutions, acids and other liquids which attack brass.

Lunkenheimer Nonpareil Generator Valves.

With the increased use and efficiency of the gasoline engine has come a demand for a generator valve which will at all times allow the correct amount of gasoline to enter the cylinder of the engine and which must be strong and durable. To meet these demands, the Lunkenheimer Company, of Cincinnati, O., make five different types of generator valves, several of which are shown in the accompanying illustrations, the principle difference being in the method used in affecting the regulation and controlling the mixture of gasoline and air to the engine.

In the type of valve shown in Fig. 1, the regulation is accomplished by a sliding valve D, which covers the outlet passage of the valve and controls the mixture of gasoline and air to the engine. The lever M is used to manipulate the valve. In Fig. 2, which illustrates another type, the mixture is regulated by the lift of the disc controlled by knurled wheel, 7, located on top of the valve. Fig. 3 represents another type, the mixture being controlled by means of the lift of the disc, together with the butterfly valve, 9, in the outlet passage. Fig. 4 represents a type which has no means whatever of controlling the mixture to the engine.

The discs in generator valves generally cause the most trouble. It is necessary, therefore, that the disc be light in weight to insure prompt action, and to prevent excessive pounding, but at the same time the discs must be strong. To combine both strength and lightness, the discs are made of a special bronze composition, the tensile strength of which is 60,000 pounds per square inch. To decrease the lift of the disc, and consequently, the excessive pounding, the valves have their seat openings considerably larger than the area of the inlet. Hence, when the

valve closes, its travel being but a trifle, the pounding and wear is reduced to a minimum. Should the discs wear, they can be reground by removing them and placing a little sand or glass and soap or oil on the seat bearings. A screw-driver or other flat instrument placed in the slot in the disc provided therefor facilitates regrinding. The end of the needle valve, which controls the supply of gasoline into the generator valve body, is placed near the outlet of the gasoline into the valve, very little clearance being allowed. The result of this is that the gasoline is injected in the form of a spray, insuring vaporizing with the air admitted through the air inlet. The disc is provided with a spring at the bottom, to insure its proper and prompt seating, and as the stem in the disc projects below the valve, the disc can be raised from off its seat by hand, whenever it is desired to prime the engine for starting purposes.

When the generator valve is applied to the crank case of a two-cycle engine, it combines both the functions of a carburetor and the usual check valve placed between it and the crank case. Its operation is dependent upon the alternate periods of pressure and partial vacuum existing in the crank case at different periods of the cycles. When the plunger of the engine moves in on the compression explosion cycle, the resultant vacuum in the crank case permits the atmospheric pressure to act upon the disc, opening same against the tension of the spring and limited also by the stem. At this period the gasoline port in the side of the valve seat is uncovered, and an amount of gasoline is sprayed into the incoming volume of air rushing into the valve, and is immediately vaporized or gasified. On the return stroke, the internal pressure within the crank case, assisted by the spring, causes the disc to seat instantly, thereby retaining the mixture within the engine and shutting off any further injection of gasoline.

The small needle valve that controls the flow of gasoline to the gasoline inlet has a long taper bearing and the stem threads

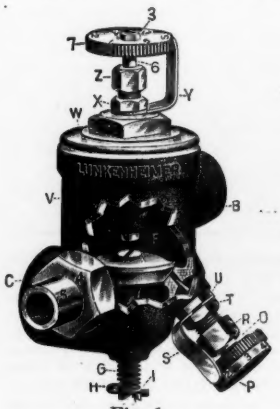


Fig. 1

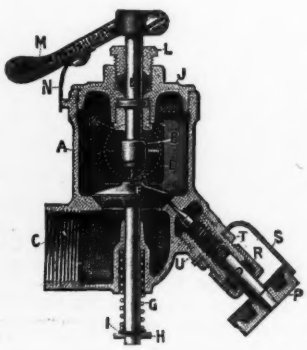


Fig. 2

are of fine pitch; thus close adjustment can be secured, and the amount of gasoline injected can be regulated. The wheel handle of the needle valve is engraved with numbers, to show the different degrees of opening. The wheel handle of the needle valve has a flat spot on its periphery which the spring engages and which enables the operator, after he has properly adjusted the needle valve for the correct mixture, to at any time easily obtain this same adjustment, should he close the needle valve or open same beyond the proper setting. No matter where this flat spot may be after the needle valve has been set, the spring can be brought to bear on it by merely loosening the lock-nut, which will permit of the free turning of the spring.

All styles of valves are made in both right and left-hand pattern. No iron or steel is used in the construction of these

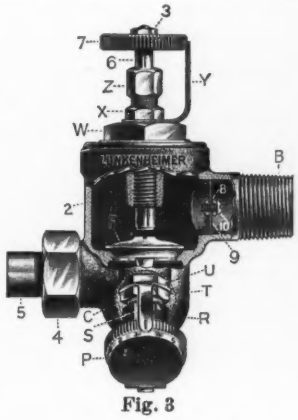


Fig. 3

Fig. 4

valves, as gasoline will quickly corrode these materials. Bronze composition is used in the construction of all the parts, the metal being so distributed as to be heaviest where the greatest strains are found.

New Uses for Aluminum.

With the increased output of aluminum, which was eighty-three pounds in 1883, and which is about seventeen million pounds this year, has come a number of new uses for this silvery metal. Among the new uses to which it is put are electric wire, crank cases and gear boxes for motor cars, panels for lining subway cars, metal plating, pigments, and cases for lightning arresters. Aluminum cases for this last purpose have proved a valuable addition to devices for protection against lightning. Owing to the high price of tin, aluminum is also being used in large quantities to replace it.

The Helion incandescent lamp, which in preliminary experiments has shown an efficiency of one watt per candle power, is not yet adaptable to commercial circuits, owing to the difficulties of using standard lamp-making apparatus in its construction. It is said, however, that when properly manufactured, they show a life of 1200 hours, and their cost will be only a trifle more than the ordinary incandescent lamp. The light emitted is much brighter and more pleasant than the carbon lamp, and when it is considered that the new 20 candle-power lamp will not take any more current than an 8 candle-power carbon lamp, the saving in fuel for a given illumination can easily be recognized.

The bursting of a tube in one of the 350 horse-power Stirling water-tube boilers in the Pennsylvania Railroad power plant at Westville, N. J., injured six workmen who were working in the boiler room. The boilers were being equipped with mechanical stokers and the men injured were working on them adjacent to the boiler which exploded. All the men injured were badly scalded, but none of them seriously.

Three large boilers located at the Kimberly mine of the Sunday Creek Coal Company, near Nelsonville, O., exploded, killing three men and wounding three.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

The growing popularity of mechanical stokers as against the old method of hand firing, is seen to best advantage at the big shops of the Wilkinson Manufacturing Co., at Bridgeport, Pa. It is here that Wilkinson Stokers are manufactured, and upon the casual visitor it leaves the impression that hand firing must be only a remembrance of days gone by, for there are stokers every where, with the shops working to their full capacity and still hardly able to fill the constantly increasing number of orders. Here you see a bunch of men rushing to complete an order of stokers that must be shipped on a certain vessel for some place in the Orient; another place are some men hurrying an order for Russia with others for England, Germany or other countries, while out on the railroad siding, which runs into the works, men are loading cars with stokers that must first go to New York, where they will be transferred to a steamer bound for New Orleans or points along the Mississippi River; some to be again transferred at St. Louis for points in the West or Southwest. Altogether, a day spent at the Wilkinson shops encourages the belief that the days of the shovel and the slice bar are fast passing.

The Hartford Engine Works, of Hartford, Conn., have recently added to their equipment of portable tools and otherwise increased their facilities for making engine and machine repairs at short notice.

The Globe Boiler Compound Co., 1002 Press Building, Binghamton, N. Y., issue a circular describing the Case Patent Metal Boiler Cleaner, copies of which they will mail upon request.

The sales of Wolff Belt Dressing are said to have doubled within a few months.

Again during the month of December Osgood Sayen, Arcade Building, Philadelphia, will give a picture of "The Matinee Girl" with every order for Johnson Pump Valves.

The Buckeye Boiler Skimmer Co., have sent us a number of letters recently received by them from users of their Buckeye Automatic Boiler Skimmer. One of the letters is as follows:

"West Monterey, Pa., 77-25-07—The Buckeye Boiler Skimmer Co., Toledo, Ohio.

"Gentlemen: Please enter our order for another one of your BUCKEYE FLOATING SKIMMERS, to be a duplicate of the last one.

"We installed two of your Skimmers last September, and think a boiler not complete without one of them. MONTEREY COAL COMPANY, Per A. J. Watson, Gen'l. Supt."

A circular describing the Wright Improved Safety Alarm Water-Column has been received from the Wright Manufacturing Co., 72 Woodbridge Avenue, Detroit, Mich. The feature of this column is that it is equipped with a whistle, which shrieks when the water level approaches the danger line. A copy of the circular will be mailed if requested.

The Nazle Engineering and Machine Works have purchased the shops and entire plant formerly owned and operated by the Corliss Engine Works, at 4105 North Fifth Street, Philadelphia. This is one of the finest and best equipped shops in the country. The special business of the Nazle firm will be the designing and building of all kinds of special machinery, and repair work.

A new circular describing the McKnight Combination Open-Feed Water Heater, purifier, muffler, oil separator, settling chamber, return tank and filter has been issued by Walter J. McKnight, 179 Washington Street, Buffalo, N. Y. This circular will prove of interest and value to engineers contemplating the purchase of a new heater. Mr. McKnight will mail a copy to any reader upon request.

Two new booklets have just been published by the Williams Gauge Co., 500 Fourth Avenue, Pittsburgh, Pa. Each of these booklets is more than ordinarily interesting, and each is handsomely printed in colors. One is entertainingly devoted to the subject of economy in general and of power plant economy in particular, while the other describes the Williams power plant equipment, including the Williams Feed Water Regulator, the Williams Steam Trap, Pump Governor, Gauge Cock and Water Gauge. Ask for a copy of each.

The United States Graphite Company, Saginaw, Mich., miners of Graphite and manufacturers of Graphite Paint, have printed a very interesting booklet, "About Graphite Paint," for structural iron work, smoke stack boiler fronts, etc., which upon request will be sent to those interested.

Every engine room should be supplied with a full equipment of Stocks and Dies, a complete line of which are described in the catalog of the Armstrong Manufatcuring Co. Many other tools of interest to engineers are shown in this catalog, especially a line of machines for threading and cutting off pipe. These machines are made in all sizes and either for hand or power. Write for a copy of the catalog to Armstrong Manufacturing Co., Bridgeport, Conn.

Usudurian Turtle Brand Sheet Packing is described in a new pamphlet issued by the manufacturers, Revere Rubber Co., Boston, Mass. Usudurian is an unvulcanized, self-vulcanizing sheet. One of its special features is that it can be built up for joints that are uneven or which come together at an angle, and by the application of naphtha it becomes one solid piece. This process is shown in the pamphlet referred to above. Another feature of Usudurian is that its "scrap" is purchased back by the manufacturers. Write for a copy of the pamphlet to Revere Rubber Co., Boston, Mass.

Richard Thompson & Co., 126 Liberty Street, New York, offer to send one of their Patent Soot Ejectors on trial, to any steam user. This soot ejector is for cleaning flues of boilers. Its special advantages are that no steam enters the flues and the soot is blown up the chimney, not out into the boiler room. If you are troubled with soot, send for one.

The New England offices of the Philadelphia Grease Manufacturing Co., have been moved to 102 High Street, Boston, where they occupy larger quarters. Mr. Harry H. Atkinson, James F. McCurdy and T. Addison Collins represent the company in New England.

"From Water to Steam" is the title of a unique booklet, a copy of which has just reached us. It contains some fifty pages and every inch of its space has been utilized in a semi-scientific discussion of the causes and effects of boiler scale. No, it isn't the same old story in the same old way, it's served up different, in tasteful morsels, daintily garnished in the interest of its cause. It starts with the water of the rivers, lakes and ocean, follows it up into the clouds, down again to the earth, and right into the steam boiler, where the subject of scale and corrosion is deftly handled and being an advertising booklet, a remedy is prescribed. For a copy of this new booklet, write The William B. Pierce Co., 329 Washington Street, Buffalo, N. Y.

The Trill Indicator Co., Corry, Pa., recently shipped an indicator outfit to the State School of Science, Wahpeton, N. D. They also advise us that they have shipped the University of Tennessee their fourth indicator and expect to ship a fourth one to the University of Minnesota.

FOR SALE.—One 16 x 26 x 42 Allis Corliss, Tandem Compound engine, first-class condition. Morehead Mfg. Co., Detroit, Mich.

POSITIONS VACANT.—Territorial agents, on contract at liberal commission, to demonstrate in boiler plants a patented machine of recognized worth, selling at moderate price. For further particulars, apply, with references, to Thomas Andrews Mnfg. Co., Rockaway, N. J.

"Advertiser is anxious to learn the present address of the following engineers who were formerly located at the addresses given below: C. W. Koehler, Tell City, Ind.; Leonard I. Cole, 148 McKinnon St., Dallas, Texas; J. M. Sullivan, 407½ Washington Ave., Danville, Ill.; Thos. E. Barnwell, Alton, Fla.; G. Garland Fickes, Care Majestic Hotel, St. Charles, La. Any information will be gratefully received by the editor." Address, Box 12, Care THE PRACTICAL ENGINEER.

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory. Address FRANCE PACKING Co., Tacony, Phila., Pa.

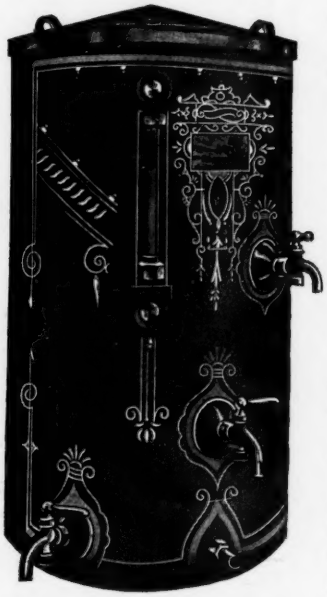
WANTED—Engineers and Mechanics to make big money selling O. K. Hand Soap. A 10-cent Can will instantly remove more dirt and stains from the hands than 4 cakes of any soap made, and it will not injure the most delicate skin. Small sample free. O. K. HAND SOAP CO., 570 Columbus Ave., Boston, Mass.

PATENTS Watson E. Coleman, Patent Attorney, Washington, D. C. Advice free. Terms low. Highest ref.

PATENTS

C. L. PARKER
Late Examiner, U. S. Patent Office.
Attorney-at-Law and Solicitor of Patents.
Patents secured promptly and with special regard to the legal protection of the invention.
Handbook for inventors sent upon request.
186 Dietz Bldg. WASHINGTON, D. C.

A Little Oil And A Great Deal Of Lubrication



At a cost of but a few cents a year you can save from 50 to 75 per cent. on oil by use of this Cross Oil Filter.

It is guaranteed against defects and represents all the best features of construction.

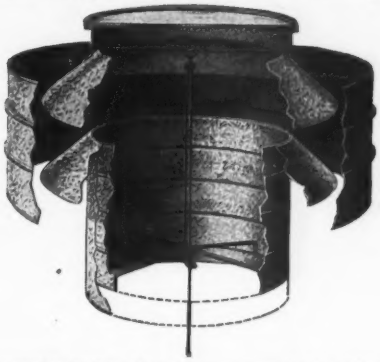
Ask for the new 80-page catalog.

The Standard Oil Co. have 88 Cross Filters in use in their own pumping stations.

The Burt Manufacturing Co.
204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

See The Glass Top And Sliding Sleeve Damper



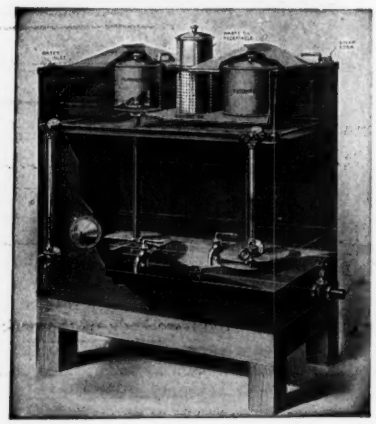
NOTICE—Sliding Sleeve Damper can be furnished with metal top if desired. (Patented).

Both light and ventilation, with perfect protection against the elements. Made of extra heavy galvanized iron—no paint to cover defects—if there were any you could easily see them.

The Nordberg Mfg. Co., Milwaukee, recently ordered 48-30 and 48 in. Burts for use on their new foundry—one of the finest in U. S. A. The Jones & Lamson Machine Tool Co., Springfield, Vt., 80-20 in.

We have an 80-page Catalog. Do you want one?

The Burt Manufacturing Co.
204 Main St., Akron, O., U. S. A.



The Burt Unit Oil Filters

So constructed that they can be operated singly or in batteries as large as may become necessary.

They remove all dirt and grit from oil, and save 50 to 90 per cent. Each unit will deliver, clean and pure, 200 to 250 gallons every 24 hours.

The Philadelphia Rapid Transit Co. uses 26 (fifth order) Units. Calumet & Hecla Copper Co., 7 (repeat orders).

Have you our new 80-page Catalog?

The Burt Manufacturing Co.
204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

The Burt Exhaust Heads

protects roofs and walls by separating every bit of condensation water and oil from your exhaust steam.

The Baldwin Locomotive Works uses 53 Burt Exhaust Heads. The U. S. Steel Corporation have 96.

How about our 80-page Catalog? Do you want one?

The Burt Manufacturing Co.
204 Main St., Akron, O., U. S. A.

Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

ANOTHER MANUFACTURER OF BIG GAS ENGINES

As an indication of the rapid development in the manufacture of big Gas Engines and the importance of the field occupied by this type of prime mover, it is of interest to note that another manufacturer of large Corliss Steam Engines has actively taken up the manufacture of Gas Engines, and is bidding strongly for engines in medium and large sizes.

The Wisconsin Engine Company, with works at Corliss, Wis., which has built some very large and successful Corliss Steam Engines, is building gas engines for all services in sizes from 400 to 5,000 B. H. P. The engines utilize natural gas, producer gas, coke-oven gas or blast-furnace gas in the Otto cycle (4-cycle), and are of the Horizontal Tandem and Twin-Tandem Double-acting type. This company controls the Sargent patents on internal combustion engines and has employed Mr. Charles E. Sargent as the engineer of its Gas Engine Department

The gas engines built by the Wisconsin Engine Co. bear some of the distinctive features of their big Corliss Engines, and utilize in design most of the Sargent patents. The design is remarkably simple and embodies features which are of considerable interest to the engineer and power user, e. g.,—there is but one poppet valve for each explosion chamber, and as this is located on the bottom of the cylinder the cumbersome and unsightly air and gas pipes, as well as the stairs, galleries and railings are entirely eliminated; provision is made for preventing the dangerous pressures caused by possible pre-ignitions, and the engines are started automatically.

The Jacobson Gas and Gasoline Engines are interestingly described in Bulletin "D," issued by the Jacobson Machine Manufacturing Co., Warren, Pa. The catalogue describes the construction and operation of the "Hit and Miss" and "Automatic" Gas and Gasoline Engines in an exceptionally clear and instructive manner. The construction of the engines is also explained in a number of line and half-tone cuts

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The construction and application of the Northern Self-Closing Safety Water Gauge is shown in a catalogue just issued by the Northern Specialty Co., 69 Columbia Street, Utica, N. Y. This type of water gauge prevents the glass from flying around the boiler room, and prevents the escape of more than an ounce of hot water from the boiler in case the glass should break. It is entirely automatic in action, it cannot be closed through ignorance or carelessness, a false water is impossible, for which reasons it is approved by government, State and municipal boards of boiler inspection. The catalogue will be sent to any engineer upon request.

H. B. Underwood & Co., 1025 Hamilton Street, Philadelphia, issue an interesting little book, entitled "Useful Hints for Engineers," a copy of which they will be glad to send to readers of THE PRACTICAL ENGINEER upon request.

A new 1908 calendar has been issued by H. B. Underwood & Co., 1025 Hamilton Street, Philadelphia, copies of which will be sent to engineers who write them for one. This new calendar is of a different style from previous Underwood calendars, being composed of twelve large sheets, one for each month, commencing with December, 07, and ending with December, 1908. These calendars are now ready.

When John Wanamaker built his new store in New York City, the Pittsburgh Gage & Supply Co., Pittsburgh, Pa., equipped his power plant with a White Star Continuous Oiling System. This installation having proved its usefulness, Mr. Wanamaker has just ordered a duplicate system for his Philadelphia store.

The Pittsburgh Gage & Supply Co. are also furnishing the Lackawanna Steel Company's Lackawanna, Pa., plant with its third system.

The Pittsburgh Gage & Cupply Co. have just moved into their new seven story factory, where, with unlimited facilities, they will be better able than ever to fill orders promptly.

PENBERTHY INJECTORS

The Penberthy Injector Company was organized in 1886. The President of the Company, Mr. S. Olin Johnson, was at that time the general manager of the Detroit Knitting and Corset Works, located at the corner of Seventh and Abbott Streets, Detroit, Michigan.

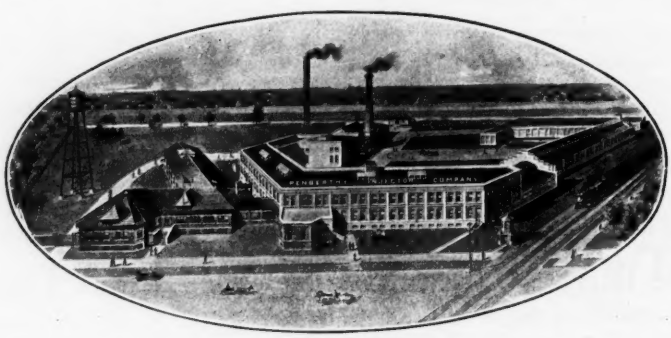
The inventor of the original Penberthy Injector was William Penberthy, of Leadville, Colorado, who on his way East stopped at the Exposition at Chicago held during that year, where he saw an exhibit of an automatic restarting injector which so interested him that he devised what he thought to be an improvement. This injector was brought to the attention of Mr. Johnson, and a patent was applied for and granted. Mr. Johnson set aside in the building of the Corset Works a room about 20 feet by 30 feet, and began the manufacture of the injector.

It is a matter of history unknown to the general public, that the injector invented by Mr. Penberthy was an absolute failure. There were 170 of these injectors made, and within sixty days after they were sent out, they were recalled and melted up.

In the meantime the company had improved on the original injector, manufacturing 4,000, which proved very satisfactory. Experiments developed another still better machine, of which some 12,000 were made and sold.

At about this time the superintendent of the company, Mr. Thomas J. Sweeney, invented the injector that has since then been sold as the Penberthy Injector, no changes having been made after the first 16,000 were manufactured as above mentioned.

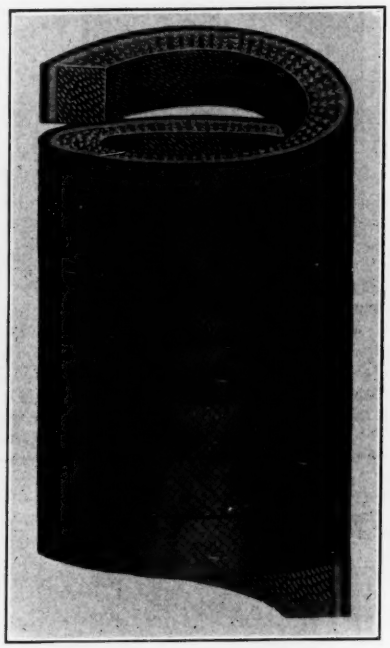
In 1886 they employed four men. They now employ from 275 to 300. In May of this year they completed the manufacture of 500,000



Penberthy injectors which does not include 50,000 under the brand of "Auto-Positive," a somewhat different type of injector.

In addition to injectors, this company manufactures a large line of boiler and engine room appliances, such as Lubricators, Oil and Grease Cups, Water Gages, Gage Cocks, etc., all fully illustrated and described in a 70-page catalog which they publish.

Rubberbestos Spiral Packing, a cut of which is shown herewith, possesses some distinct features of construction which may be of interest to many of our readers. The body of this packing is diagonally construted in such a way that the plies of fibre or cloth run diagonally around the rod. As the gland is tightened up, the plies of cloth straighten, thus allowing for additional compression and increas-



ing its durability. Another feature which is out of the ordinary, and to which the manufacturers call special attention, is the position of the rubber in this packing. It will be seen that the rubber is at the back, the object of which is to protect it from the friction of the rod, permitting it to give life and resiliency to the packing until the fibre body of the packing is entirely worn away. This strip of rubber is of the material known as pure Rubberbestos, which is a special composition intended to withstand high temperatures. Rubberbestos Spiral is made by A. W. Chesterton & Co., 64 India Street, Boston, Mass.

KEYSTONE GREASE

LUBRICANT TRADE MARK REGISTERED

LUBRICANT TRADE MARK REGISTERED

An Engineer's Cap

Large Can of Keystone Grease

A Fine Brass Grease Cup

FREE

VIENNOT-PHILA

A CHRISTMAS OFFER

To every engineer who will fill in and mail us this coupon we will send

Absolutely Free

EXPRESS CHARGES PREPAID

A LARGE CAN OF KEYSTONE GREASE—
AN ENGINEER'S CAP—and
A FINE BRASS GREASE CUP.

There is no string attached to the proposition. No money will be asked now or afterwards—All we ask is the opportunity to demonstrate to your satisfaction that one pound of Keystone Grease will last longer and lubricate better than three to four pounds of any other grease, or four to six gallons of the best lubricating oil.

Are you willing to make the test?

If so fill in the coupon now, and mail it to the

Keystone Lubricating Co., Dept. F.
PHILADELPHIA, PA.

New England Office :—No. 10 Oliver Street, Boston, Mass.
Southern Office :—No. 610 Chartres Street, New Orleans, La.

Name.....

Name of Firm .....

Address.....

.....

.....

H. P. of Engine .....

On What Bearing will Sample be Tested

.....

R. P. M.....

Size of Tap for Cup.....

Size of Cap Wanted .....

NEW POWER PLANTS AND IMPROVEMENTS

The Alpha Cement Company, of Easton, Pa., intends building a large hydro-electric power plant along the Pennsylvania side of the Delaware River, near Foulrift. The electric current generated will be transmitted to the company's large cement mills at Martin's Creek, Pa., and Alpha, N. J.

The Choctaw Railway and Lighting Co., of McAllister, Okla., are making extensive improvements, amounting practically to a complete change in the equipment of their power plant.

The Oro Water, Light and Power Co., is building a new power plant of Coal Canyon, near Oroville, Cal. Upon completion the new plant will have a capacity of 1,500 horsepower.

The Hoover Prout Company, of Avery, O., are making extensive improvements to their plant. A new power house 40 feet square will be built, and electric power will be used in operating the company's machinery.

The Columbus Railroad Company, of Columbus, Ga., are planning improvements to increase the capacity of their power plant.

The Delaware and Hudson Co. are installing machinery in their new power plant at Mechanicville, N. Y. It is expected that the new plant will generate 6,000 horsepower, which will be used by the United Traction Company to operate all their street railway lines in Albany and Troy.

The City Council of Ft. Wayne, Ind., will shortly build a new power house for the municipal lighting plant.

The Michigan Power Company, of Lansing, Mich., will build a new steam power plant at Ottawa and Grand Streets. After the new plant is erected the company will abandon their old steam power plant on Washtenaw Street.

A new municipal light plant is being installed in the basement of the City Hall of Newark, N. J. The new plant will be used for lighting the City Hall.

The San Antonio Traction Co., San Antonio, Texas, will shortly build a new power plant on the San Antonio River. Estimated cost, $200,000.

An addition is being built to the municipal power plant of Aurora, Ill., which will greatly increase the light producing capacity of the plant. C. H. Caustin & Son, of St. Charles, Ill., have the contract.

The San Diego Electric Railway Company, of San Diego, Cal., are making extensive alterations to their power plant.

The Independent Mining Co. is building a hydro-electric power plant on Trail Creek, near Hailey, Idaho. Estimated cost, $30,000.

St. Francis Hospital, Pittsburgh, Pa., will build a new brick stone and steel power house, 65x138 feet, for lighting and heating the institution.

The City Council of Winnipeg, Manitoba, Can., have decided to build a municipal hydro-electric power plant.

The University of Maryland, at Baltimore, will shortly erect a new power house.

The Southern Pacific Railroad Company will build a large hydro-electric power plant at Clark, a small station sixteen miles east of Sparks, Nevada. The plant will have a capacity sufficient to supply all the needs of the railroad terminals at Sparks and Reno, and to furnish commercial current to adjacent towns.

SOCIETY NOTES

A very successful meeting of the New Haven Association of Stationary Engineers was recently held at the Boardman building. An illustrated lecture was delivered by J. J. McMahon and A. Godfrey and Charles Albee gave demonstrations of steam packings. A smoke consuming device was described by C. H. Chase. Secretary Behler, of the Board of Examiners of Engineers, also made a short address.

An open meeting of all the Philadelphia associations of the N. A. S. E. was held at the Bourse on October 25th, to commemorate the twenty-fifth anniversary of the founding of the parent organization. Mr. Ernest C. Fox, who presided over the meeting, spoke of the principals and purposes of the N. A. S. E. The next speaker was Robert Halpin, who gave a description of the method and construction of sand filters. The other speakers were V. L. Rupp, who spoke on the value of education; James Gillespie, who spoke on the past and future opportunities of the N. A. S. E., and Harry McAllister, who was billed to speak on electricity. The latter speaker, however, eulogized the memory of Samuel W. Hibbs, who was past president of Quaker City Association No. 1, and who that afternoon died suddenly after many years of service as a stationery engineer. The meeting then adjourned to the refreshment hall, where the rest of the evening was spent in social enjoyment.

The Chicago members of the National Association of Steam Engineers celebrated the silver anniversary of the founding of the association in the banquet room of the Auditorium Hotel on October 27. The theme of the evening was "The Important Part That the Trained Engineer Plays in Modern Industry," and its different aspects were discussed by the after-dinner speakers.

A series of lectures are being given every alternate Tuesday evening by the Baltimore Md., N. A. S. E. These lectures are for the instruction and advancement of the members and are upon subjects related to steam and its application. The first six lectures of the course are being delivered by William H. Hall, of the Polytechnic Institute.

A public meeting of the Battle Creek, Mich., Association of Stationary Engineers was held on November 16, in which the need of an engineers' license law, the better education of the engineer, and the improved efficiency of the modern power plant were discussed.

The report of W. E. Kennedy, chief examiner of stationary engines in the State of Ohio, shows that for the month of October, the receipts of his office were $2,732 from license fees. The report also shows that during the month there were 298 applications, of which 120 were refused and 178 were issued, and 1,086 licenses were renewed.

The Engineers' Club of Philadelphia are about to move from their old quarters, 1122 Girard street, to their new building, 1317 Spruce Street. The new club house is admirably fitted up for club purposes. The first floor will be used for the reading, conversation and dining rooms, the second floor will be used for the auditorium, billiard room and office, and the upper floors will be used for bed rooms and other club purposes. The new building is in the heart of the city, and its opening will mark a distinct advance in engineering circles in Philadelphia. Its present officers are: President, Henry H. Quimby; vice-presidents, Washington Devereux, W. P. Dallet; treasurer, George T. Gwilliam; secretary, Walter L. Webb.

The first annual meeting of the Eastern Ice Association was held in Continental Hotel, in Philadelphia, November 7-8. The sessions were full of technical interest as a number of papers were read pertaining to ice and its manufacture. Among the interesting papers read were "The Manufacture of Plate Ice," by Karl Wegeman; "The Storage of Manufactured Ice," by John S. Bell; "Cooling Towers in Refrigerating Plants," by B. F. Hart, Jr.; "Vacuum Ice Systems," by John Patten; "Producer Gas in Refrigeration," by Ellis L. Phillips; "Exhaust Steam in Refrigeration," by Henry Torrance. The election of officers resulted as follows: President, C. Q. Guldin; Vice-President, H. W. Bahrenburg; Secretary-Treasurer, W. H. Ross; Executive Committee, A. D. Warner, C. G. Wingfield, H. E. Bester, T. V. Uttley, H. D. Stratton, H. W. Cole, J. H. Forman, E. W. Neuman, Miller Stradley.

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